X-6614

MAINTENANCE MANUAL

COACH MODEL

PD-4107

GMC TRUCK & COACH DIVISION
GENERAL MOTORS CORPORATION
Pontiac, Michigan

55020

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INDEX

INTRODUCTION

This manual contains complete service, maintenance, and repair information on GM Inter-City Coach Model PD-4107. Information in this manual pertains to standard equipment and the most commonly used special equipment.

Operation of the vehicle from the standpoint of the driver is contained in a separate Operating Manual. For information on the Diesel Engine, refer to the current Diesel Engine Maintenance Manual.

Every effort has been made to include timely and adequate information on the various units and systems used on the PD-4107 Coach. The maintenance and repair procedures in the various manual sections are the result of extensive service experience. This information should serve not only as a reference for the experienced mechanical force, but also as a comprehensive text for training purposes.

All information contained in this manual is based on the latest product information available at the time of publication approval. GMC Truck and Coach Division reserves the right to make product changes at any time.

GENERAL INFORMATION ABOUT THIS MANUAL

MANUAL ARRANGEMENT

This manual is divided into major sections in the sequence shown on the margin of the title page. A black tab bearing the major section number is placed on the first page of each major section which indexes with the tab on the title page. Many of the major sections are divided into sub-sections, each sub-section containing important and specific information on related units or components. When a major section is divided into sub-sections, a section index appears on the first page of the major section.

PAGE AND ILLUSTRATION NUMBERS

The manual pages are numbered consecutively throughout the manual. Illustrations are numbered consecutively within each section, or within each sub-section when the major section is so divided.

SPECIFICATIONS

Service data, fits, and tolerances are listed at the end of most sections or sub-sections under the heading "Specifications." Manufacturers model or part numbers are used in many instances in the "Specifications" tabulation. These numbers are provided primarily for unit identification and should be referred to when ordering parts. All detail service part numbers must be obtained from the applicable Parts Book.

SPECIAL TOOLS

Special tools and equipment are mentioned, and in many instances illustrated, throughout the text. These tools are specially designed to accomplish certain operations efficiently and readily. Such tools are identified in the text by tool vendor's numbers. These tools are not offered for sale by GMC Truck and Coach Division. Information regarding availability of these tools can be obtained from your GM Coach Service Representative or from the Factory.

SERVICE BULLETINS

Service bulletins are issued, when required, supplementing or in some cases superseding information in this manual. Information in these bulletins should be noted in the text and the bulletin filed for ready reference.

ALPHABETICAL INDEX

Important subjects, with manual page number references, are alphabetically listed at the end of this manual.

GENERAL DATA

The data listed below includes only general information on the PD-4107 Coach. For specific data and specifications, refer to "Specifications" at end of each section or sub-section.

MODEL DATA

Length (overall)	35 ft.
Width (overall)	95¾ in.
Height (maximum)	131½ in.
Wheelbase	261 in.
Track	
Front	79¼ in.
Rear (center of dual tires)	70½ in.
Turning Radius	
Wheels (right and left)	39 ft.
Body Corner (right and left)	43 ft.
Tire Size (standard)	12.00/22.5
Fuel Tank Capacity	Standard—140 gal.
	Optional—165 gal.
Cooling System Capacity (including heating system)	92 qts.

ENGINE DATA

Engine Model	8V-71N
Displacement	567.5 cu. in.
Bore and Stroke	4¼ in. x 5 in.
Compression Ratio	18.7:1
Brake Horsepower at Governed Speed (1800 rpm)	252

SERIAL NUMBER LOCATIONS

Delay and confusion can be avoided when correct serial numbers of vehicle and engine are placed on parts orders and correspondence. Locations of these serial numbers are illustrated below.

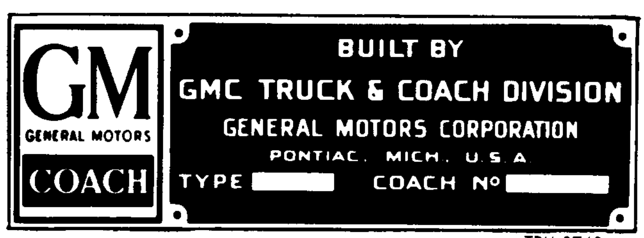

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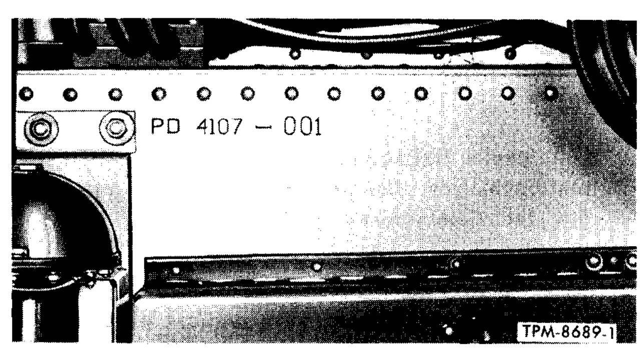
PLATE ON RIGHT SIDE OF DASH

RIGHT SIDE OF CYLINDER BLOCK



ON BULKHEAD IN TOOL COMPARTMENT

Front Axle

This group is divided into two sections covering "FRONT END ALIGNMENT" and "FRONT AXLE REPAIR."

Front End Alignment

Proper front end alignment must be maintained to insure ease of steering and satisfactory tire life.

Front end alignment inspections generally fall into two groups: (1) Regular service inspections performed at periodic intervals, and (2) Inspections to determine extent of damage after a collision or severe service.

Regular service inspections are primarily concerned with toe-in, camber, and caster. With proper equipment these specifications are easily checked. Any variation from these specifications will indicate: (1) need for adjustment, or (2) more thorough inspection to determine if any steering or front axle parts are bent and require replacement.

Complete front end alignment data is given under "Front End Alignment Data" at end of this section.

DEFINITION OF TERMS

WHEEL TOE-IN. Distance front wheels are closer together at front than at rear of axle (see "G" minus "H," fig. 1).

WHEEL CAMBER. Amount wheels are inclined from vertical plane (see "C," fig. 1).

FRONT AXLE CASTER. Inclination of king pin from the vertical in the fore and aft direction of the vehicle (see "X," fig. 1).

KING PIN INCLINATION. The slant of the king pin toward the center of the vehicle at the top and outward at the bottom (see "D," fig. 1).

STEERING GEOMETRY. The design of the front end which causes the front wheels to stay in proper relative alignment when the wheels are turned to right or left.

FRONT END INSPECTION

Before checking front end alignment, the following front end inspection should always be made:

1. Check tires for proper inflation.
2. Check wheel installation and run-out.
3. Check wheel bearing adjustment.
4. Check tie rod and drag link ends for looseness.
5. Check king pins for looseness.

Front end alignment requires the vehicle to be level while being checked. Full weight must be on wheels with vehicle empty.

ALIGNMENT

FRONT WHEEL TOE-IN

Toe-in is measured from centers of tire tread. Measurements at both front and rear of axle (see "H" and "G," fig. 1) must be made at same height from floor.

First hoist front of vehicle and spin wheels to obtain a center line on tire treads.

Place wheels in straight-ahead position.

Roll the vehicle straight ahead for several feet to where the inspection is to be made. This will remove any slack caused by looseness in the wheel bearings or steering connections.

Measure at point "H" and "G" (fig. 1). Toe-in is "G" minus "H."

Incorrect toe-in results in excessive tire wear caused by side slippage. Unstable steering with a tendency to wander may also result.

Toe-in Adjustment

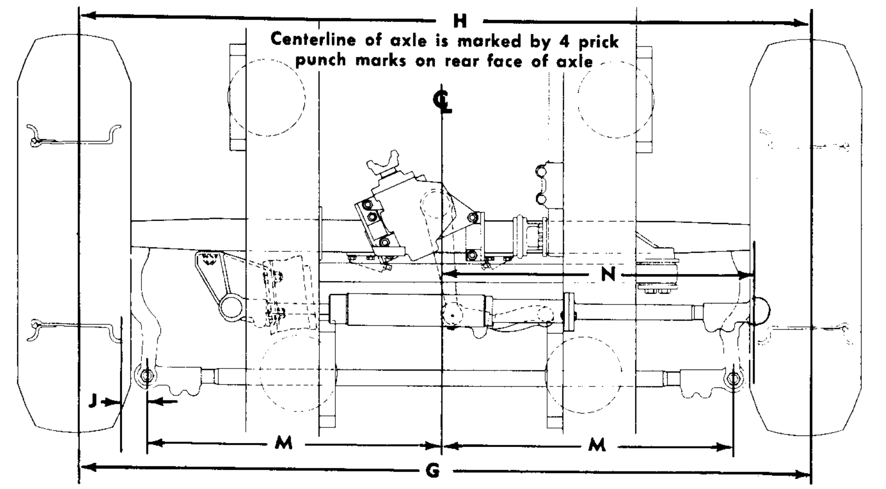
NOTE: If toe-in has to be changed a considerable amount, drag link must be removed, then reinstalled and readjusted so steering gear will not be thrown off high point.

1. Loosen clamp bolts which retain each tie rod end on tie rod.
2. Using a pipe wrench, turn tie rod tube as required to obtain correct toe-in measurement.
3. After correct adjustment is obtained, make certain that both tie rod ends are in the same plane; then tighten all clamp bolts firmly.
4. Recheck toe-in to make sure adjustment was not changed when clamp bolts were tightened.

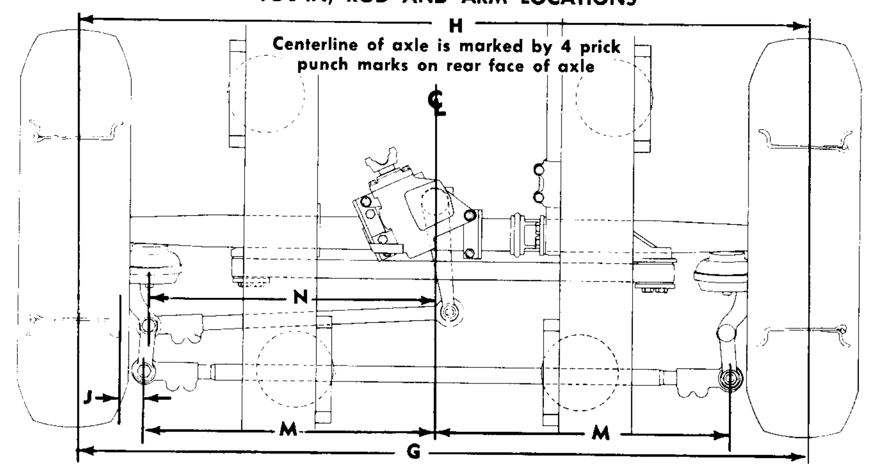
FRONT WHEEL CAMBER

Positive Camber is outward inclination of wheels at top; Negative or Reverse Camber is inward inclination of wheels at top. This vehicle is designed with positive camber. Camber variations may be caused by wear at wheel bearings and

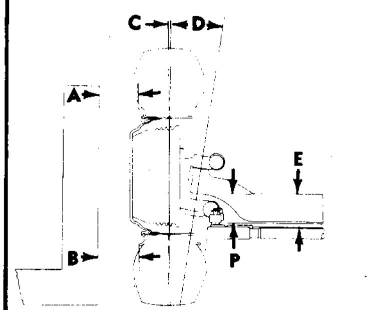
FRONT END ALIGNMENT



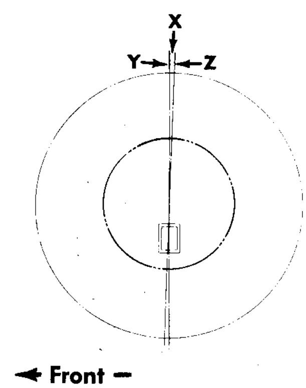
With Power Steering
TOE-IN, ROD AND ARM LOCATIONS



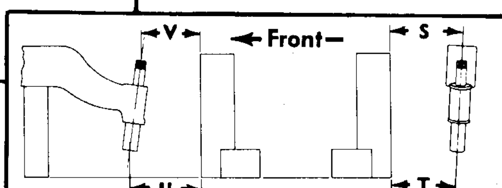
With Mechanical Steering
TOE-IN, ROD AND ARM LOCATIONS



CAMBER, PIN INCLINATIONS, AND ROD LOCATIONS



FRONT AXLE CASTER



KING PIN INCLINATION **CASTER**

B MINUS A	Camber (Inches)
C	Camber (Degrees)
D	King Pin Inclination (Degrees)
E	Top of Tie Rod Tube Below Top of Axle
G MINUS H	Front Wheel Toe-in (Inches)
J	Centerline of Tie Rod End Stud to Wheel Rim
M	Centerline of Axle to Center of Tie Rod End Studs
N (MECH.)	Centerline of Axle to Center of Steering Arm End (At Drag Link)
N (POWER)	Centerline of Axle to Center of Extension End Stud
P	Bottom of Tie Rod Arm Boss to Top of Axle Beam
S MINUS T	Caster (Inches) (Measure at Front of Axle)
U MINUS V	King Pin Inclination (Inches)
X	Caster (Degrees)
Y	Vertical
Z	Centerline of King Pin

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Figure 1—Front End Alignment Chart

steering knuckle bushings, or by bent steering knuckle or sagging axle center.

In checking camber it is recommended that an accurate gauge be used. If a camber gauge is not available, readings can be taken as illustrated at "A" and "B" on chart (fig. 1). Place square as shown and measure distance between "A" and rim, and "B" and rim. Lower dimension should exceed upper dimension by amount listed in "Front End Alignment Data" at end of this section. This dimension on right wheel should not vary over 3/32" from same dimension taken at left wheel.

If final camber reading is incorrect, either steering knuckle or axle center is bent. To determine which part is bent, check king pin inclination ("D," fig. 1). Camber plus king pin inclination is the INCLUDED ANGLE of steering knuckle. If included angle of knuckle varies more than 1/2 degree from values given in "Front End Alignment Data," knuckle is bent.

Excessive positive camber results in irregular wear of tires at outer shoulders. Negative or reverse camber causes wear at inner shoulders. Ease of steering is affected by any deviation from specified camber.

AXLE CASTER

Positive Caster is the inclination of the king pins toward rear of vehicle. Negative or Reverse Caster is the inclination of king pins toward front of vehicle. This vehicle is designed with positive caster.

Caster variations may be caused by bent axle, or tilting of side suspension supports. Precision instruments must be used to check caster angles when axle is installed in vehicle.

Caster can be adjusted on vehicle by loosening clamp bolts in adjusting clamp (fig. 2) and turning clamp. Adjust to dimension listed in "Front End Alignment Data" on next page. Tighten clamp bolts firmly after adjustment.

When axle is removed from vehicle, check can be made on bench as follows:

Place two uniform blocks on level surface. Rest suspension support seats on blocks. Using square, measure "S" and "T" dimensions (fig. 1) at front side of axle. "S" minus "T" equals caster in inches. If this dimension does not agree with specified value, the axle is twisted.

The purpose of caster is to provide steering stability by keeping the wheels in a straight-ahead position. Variations from specified caster values will affect steering stability causing wandering, difficulty in pulling out of curves, and a tendency toward wheel shimmy.

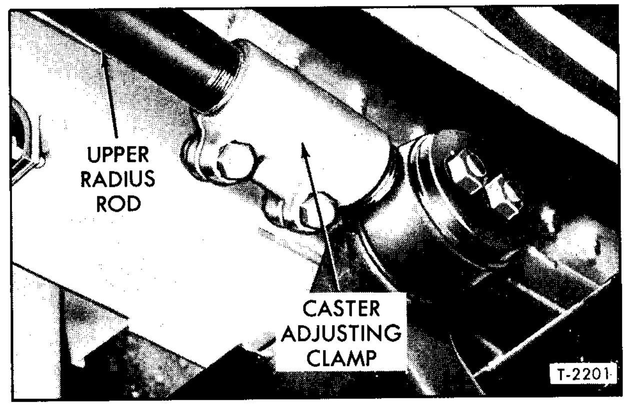


Figure 2—Caster Adjusting Clamp

KING PIN INCLINATION

Precision instruments must be used to check king pin inclination when axle is installed in vehicle. When axle is removed, check can be made on bench as follows:

Place two uniform blocks on level surface, rest suspension support seats on blocks. Using square, measure "U" and "V" dimensions (fig. 1). "U" minus "V" equals king pin inclination in inches.

If axle is bent or twisted, axle center must be replaced.

STEERING GEOMETRY (Refer to Fig. 1)

Since the angularity of the steering arms largely controls steering geometry, checking the alignment of the steering arms and linkage is an important alignment factor.

After making all other front end alignment checks, inspect steering arms for proper installation, then measure steering arm angles as follows:

1. Position of top of tie rod tube below top of axle ("E").

2. Distance of center of tie rod end studs to edge of wheel rims ("J").

3. Distances of center of tie rod end studs to centerline of axle ("M").

4. Distance from centerline of axle to center of steering arm end (at drag link) ("N") (Mech. Steering).

5. Distance from centerline of axle to center of extension end stud (at steering arm) (N") (Power Steering).

If these dimensions are not within specified values, the steering arms or steering linkage are bent and should be replaced.

Refer to next page for "Front End Alignment Data."

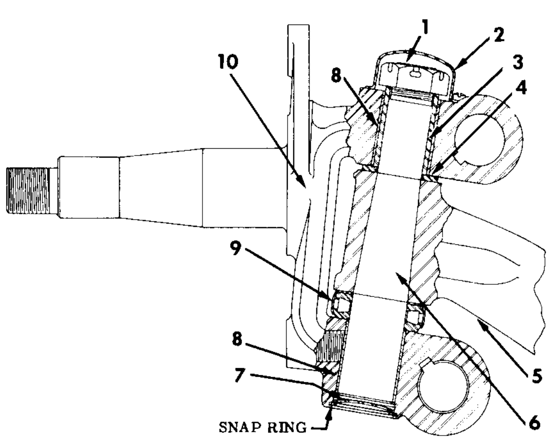
FRONT END ALIGNMENT DATA

(Refer To Front End Alignment Chart, Figure 1)

POINTS ON CHART		DIMENSIONS
B MINUS A	Wheel Camber (Inches)	13/32
C	Wheel Camber (Degrees)	1
D	King Pin Inclination (Degrees)	8
E	Top of Tie Rod Tube Below Top of Axle (Inches)	5 7/8 plus or minus 1/8
G MINUS H	Front Wheel Toe-in (Inches)	0 to 1/16
J	Centerline of Tie Rod End Stud to Wheel Rim (Inches)	2 15/32
M	*Centerline of Axle to Center of Tie Rod End Studs (Inches)	32 5/32
N (MECH.)	*Centerline of Axle to Center of Steering Arm End (At Drag Link) (Inches)	31 23/32
N (POWER)	*Centerline of Axle to Center of Extension End Stud (Inches)	32 5/8
P	Bottom of Tie Rod Arm Boss to Top of Axle Beam (Inches)	5
S MINUS T (MECH.)	Caster (Inches) (Measured at Front of Axle)	5/8
S MINUS T (POWER)	Caster (Inches) (Measured at Front of Axle)	5/16
U MINUS V	King Pin Inclination (Inches)	1 1/2
X (MECH.)	Caster (Degrees)	1 1/2-2
X (POWER)	Caster (Degrees)	3
	Front Wheel Track at Ground (Inches)	79 1/4

*Centerline of Axle is Prick-punched on Face of Axle Beam

Front Axle Repair



1 King Pin Nut
2 King Pin Cover
3 King Pin Bushing
4 Spacing Washer
5 Axle Center End
6 King Pin
7 Expansion Plug
8 Steering Knuckle Bushing
9 Thrust Bearing Assembly
10 Steering Knuckle

Figure 1—Steering Knuckle Assembly

CONSTRUCTION

Front axle assembly is Reverse Elliott type. Axles are equipped with steering knuckles constructed as shown in figure 1.

Wheel bearings, air suspension, steering gear housing, and brake parts which are mounted on front axle are described in their respective sections in this manual.

Specifications and pertinent front axle service information are given in "Specifications" at end of this section.

Front axle assembly center section is a hollow rectangular tube in which dowel pins are installed to locate air suspension supports. Outer ends of axle are solid forgings machined to accommodate steering knuckles and king pins.

Steering knuckles (fig. 1) are supported on solid king pins which are tapered at center section to fit snugly in tapered holes in axle outer ends. Nut installed at threaded upper end of each king pin locks king pin bushing (3, fig. 1) against washer (4, fig. 1) and secures king pin in axle. King pin nuts are secured by cotter pins.

Load is transmitted from axle center to steering knuckles through tapered roller thrust bearing assemblies (9, fig. 1). Covers and plugs (2 and 7, fig. 1) exclude dust and moisture from knuckle bushings and serve as lubricant seals. Steering knuckle bushings can be replaced when necessary. Stop screws installed at each end of axle center limit turning angle of front wheels.

FRONT AXLE GENERAL MAINTENANCE

INSPECTION

Following inspection operations should be performed at intervals determined by severity of service.

1. Inspect air suspension support stud nuts and U-bolt nuts. Tighten as directed in AIR SUSPENSION (SEC. 14).
2. Inspect and tighten tie rod arm and steering arm nuts. Torque specifications are shown in "Specifications" at end of this section.
3. Inspect steering arm and tie rod arm nuts for looseness. Tighten if necessary. Also inspect tie rod end stud nuts for looseness and check tie rod ends for wear.
4. When steering difficulty or abnormal tire wear indicate necessity, check front end alignment as previously instructed under "FRONT END ALIGNMENT."
5. Check stop screws and adjust when necessary. Stop screw adjustment procedure is described later.
6. Lubricate front axle parts as instructed in LUBRICATION (SEC. 13).
7. When lubricating front axle parts, observe condition of seals at steering knuckle, tie rod ends, and drag link. If seals are found to be damaged or missing, new seals should be installed immediately.
8. Periodic inspection should be made at steering knuckles to determine if excessive up-and-down movement of knuckles on king pins exists. Since excessive pounding will damage thrust bearing (9, fig. 1), the up-and-down movement of steering knuckles must be kept within prescribed limits. Shims for use in reducing clearance are available.

STOP SCREW ADJUSTMENT

Stop screws, installed in front axle center, limit front wheel turning angle to right and left. Stop screws must be set properly to give equal turning radius to the right and to left, as well as to limit turning angle and thereby prevent interference between front tires and other parts of coach.

Before setting stop screws, refer to STEERING GEAR (SEC. 16) and be sure Pitman arm is properly installed on steering gear, and be sure steering gear drag link is properly adjusted for length. Also, make sure air suspension is pressurized.

Adjust stop screws as follows:

1. Raise front axle until front wheels are off floor.
2. Turn front wheels to extreme left, measure and record distance from left front tire to nearest point on coach. In this position there should be a 3/4 to 1-inch clearance.
3. If not within 3/4 to 1-inch, turn stop screw in or out until proper clearance is obtained. Secure stop screw setting with lock nut, and recheck to make sure dimension was not changed when lock nut was tightened.
4. Turn wheels to extreme right position and repeat procedure mentioned above at right front tire. If this dimension is not same as the corresponding dimension at left-hand side of coach, adjust right stop screw to provide same dimension.
5. When adjustment is completed, road test coach and note if any interference takes place between tires and other parts of coach while making sharp turns in either direction.

FRONT AXLE REPLACEMENT

Refer to AIR SUSPENSION (SEC. 14) for procedures necessary to remove and install front axle assembly.

FRONT AXLE OVERHAUL

Steering knuckles, king pins, and bushings may be replaced without removing front axle assembly from vehicle. However, when front axle assembly requires a complete overhaul, the assembly may be removed.

Certain preliminary inspections can be made, while axle is still mounted on vehicle, which will aid in determining the amount of repair work necessary. Check front end alignment as previously directed in "FRONT END ALIGNMENT" section. Inability to align front end correctly indicates that axle center or steering knuckle is distorted, steering arms are bent, or bushings in steering knuckle yokes are worn beyond limits. Repair procedures on such items as brakes, wheel bearings, and steering gear are covered in respective sections of this manual.

STEERING KNUCKLE REMOVAL

If desired, steering knuckles may be removed from front axle without removing front axle assembly from the vehicle. To remove steering

knuckles from the axle either with or without removing the front axle assembly from vehicle, proceed as follows:

1. Remove cotter pins and nuts from tie rod end studs, then using a soft plastic hammer, tap studs until tie rod is loose; remove tie rod.
2. On vehicles equipped with mechanical steering, remove drag link from steering arm. On vehicles equipped with power steering, remove extension and end socket assembly from steering arm as directed in STEERING (SEC. 16) of this manual.
3. Remove front wheels, hubs, and bearings. Refer to HUBS, WHEELS, AND TIRES (SEC. 19).
4. Remove air brake mechanism and brake shoes. Detach brake shoe spider from knuckle and remove spider, camshaft, and slack adjuster as an assembly.
5. Remove nuts from steering tie rod arms and drive arms out of steering knuckles.
6. Remove cover (2, fig. 1) from top of knuckle to expose king pin nut. Remove snap ring from knuckle lower yoke and remove expansion plug.
7. Remove cotter pin, then remove nut from upper end of king pin. Using suitable brass drift, drive king pin downward out of axle and knuckle. Remove knuckle, thrust bearing, and spacing washer from axle. King pin bushing can be lifted out of knuckle upper yoke.

CLEANING

Wash steering knuckle parts in cleaning solution, being sure to remove all dirt and lubricant. If necessary, soak thrust bearings in cleaner until all old lubricant is dissolved; then slush bearing in cleaning solution until all grit is removed from races.

INSPECTION AND REPAIR

STEERING KNUCKLES

After steering knuckles have been cleaned, thoroughly examine knuckles for distortion, damage, cracks, or fractures. If Magna-Flux inspection equipment is available, use this method to inspect steering knuckles and king pins for minute cracks, checks, or fractures which otherwise would not be visible to the naked eye.

AXLE CENTER

There are two conditions which, if either exists, will necessitate replacement of axle center.

1. If king pin holes in axle center ends are worn to such an extent that a new pin fits loosely, axle center must be replaced.
2. If axle center has been twisted or bent more than 5 degrees from original shape, the center should be replaced. When an extreme bent condition exists, minute invisible fractures may occur and cause failure under ordinary operating conditions.

Checking Axle Center

Check axle center for twist with alignment instruments, or on a bench as illustrated in front end alignment chart (fig. 1 in "FRONT END ALIGNMENT" section). If equipment is available, use Magna-Flux method to check axle center for minute fractures.

THRUST BEARINGS

Examine thrust bearings for excessive wear, pitting, or other damage. If these conditions are evident or if bearing retainers are bent or damaged, bearings should be replaced.

BUSHING REPLACEMENT

Steering knuckle bushings should be replaced if inspection reveals that they are scored, worn, or otherwise damaged.

Removal

1. Clamp steering knuckle securely in vise equipped with soft jaws.
2. Thread tap of suitable size into bushing, if bushing driver is not available.
3. Using soft metal rod, slightly smaller than bushing and long enough to extend at least 1-1/2" through opposite knuckle yoke, drive tap and bushing out of knuckle bore.
4. Repeat process to remove remaining steering knuckle bushing.

Installation

1. Clean the steering knuckle bushing bores, then round off all sharp edges of new bushings slightly.
2. Position bushing so that oil hole in bushing will line up with lubrication fitting hole in steering knuckle yoke, and so that bushing will enter knuckle bore straight when pressed into yoke.
3. Using arbor press and suitable installer, press bushing (8, fig. 1) into knuckle bore until positioned as shown in figure 1. NEVER ATTEMPT TO DRIVE BUSHINGS WITH HAMMER.
4. Ream or hone bushings to diameter given in "Specifications" at end of this section.
5. Clean cuttings out of oil grooves, then round off all sharp edges in grooves.

KING PIN

Check diameter of king pin at upper and lower bearing surfaces against dimensions given in "Specifications" at end of this section. If wear exceeds limits given, replace with new king pin.

King pins should also be inspected for minute cracks or other damage.

STEERING KNUCKLE INSTALLATION

The importance of cleanliness when assembling steering knuckle parts cannot be overstressed. If the king pins and bushings are installed with particles of dirt or metal between bearing surfaces, excessive wear will result necessitating premature replacement of parts.

Install steering knuckles and king pins in the following manner. Key numbers in text refer to figure 1.

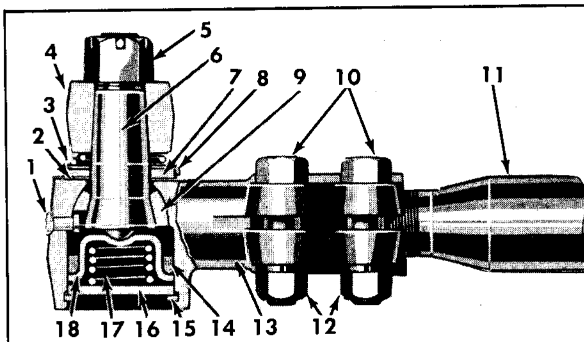
1. Position steering knuckle (10) on axle center end (5), then slide thrust bearing assembly (9) into place between lower face of axle center and steering knuckle lower yoke. Make sure retainer is on top of bearing with lip of retainer down. Align king pin holes in steering knuckle yokes with king pin hole in axle center end.
2. With axle center held rigidly, place a jack under knuckle yoke and raise knuckle sufficiently to take up all clearance between lower yoke, thrust bearing, and lower face of axle center end.
3. Check clearance between top face of axle center end and lower face of steering knuckle yoke, then select shim and spacing washer (4) combination which will reduce clearance to limits given in "Specifications" at end of this section. Shim and spacing washer thicknesses available are given in "Specifications" at end of this section.
4. Make certain king pin hole in axle center (5), king pin (6), and nut (1) are carefully cleaned and dry. King pin nut (1) should screw on king pin freely without binding in any manner. These precautions should be taken to assure king pin being securely locked in place when installation is completed.
5. Insert king pin (6) through bottom yoke of steering knuckle (10), then drive king pin into place with lead hammer.
6. Place king pin bushing (3) over threaded end of king pin (6), then press bushing into place. Be sure king pin bushing is installed squarely on king pin.
7. Make sure threads on king pin nut are clean and dry, then install king pin nut (1). Tighten nut with torque wrench to minimum torque given in "Specifications" at end of this section, then tighten nut until next castellation on nut lines up with cotter pin hole through king pin. Install new cotter pin, full size of cotter pin hole.
8. Position new cover gasket on steering knuckle upper yoke, place cover (2) on gasket, then secure cover with attaching screws.
9. Install new plug (7) in lower yoke, then install snap ring to retain plug. Install plug with concave side toward snap ring so edge of plug contacts ring.
10. Place keys in keyways in tie rod arms and steering arm and drive arms into tapered holes in knuckles. Install nuts and lock washers on arms and tighten nuts to torque specified in "Specifications" at end of this section. Secure nuts with cotter pins.
11. Install brake spider and camshaft assembly on knuckle, install brake chambers, and connect chamber push rods to slack adjusters. Install brake shoes, hubs and bearings, and brake drums. Refer to HUBS, WHEELS, AND TIRES (SEC. 19) for instructions for adjusting wheel bearings.
12. Install tie rod assembly, then on vehicles equipped with mechanical steering, connect drag link to steering arm; on vehicles equipped with power steering, connect extension and end socket assembly to steering arm as directed in STEERING (SEC. 16) of this manual.

TIE ROD

Tie rod assembly is three-piece unit comprised of a rod and two end assemblies. Rod is threaded into ends and locked with clamp bolts. Right- and left-hand threads are provided on tie rod to facilitate toe-in adjustment.

Tie rod ends (fig. 2) are constructed to automatically compensate for wear on bearing surfaces. Tie rod end stud is held in contact with bearing surfaces by tension of spring which holds seat firmly against inner end of stud. Tie rod end parts are held in place by a retaining plug and lock ring.

Normal wear on bearing surface in tie rod end will cause increase in overall height of assembly. If excessive play is noted, the parts which are worn must be replaced, or a new tie rod end assembly must be installed.



1 Dowel Pin	10 Clamp Bolt
2 Dust Seal Washer	11 Tie Rod
3 Dust Seal Spring	12 Bolt Nut
4 Steering Arm	13 Tie Rod End
5 Stud Nut	14 Grease Seal
6 Stud	15 Lock Ring
7 Dust Seal	16 Retaining Plug
8 Dust Seal Retainer	17 Seat Spring
9 Stud Bearing	18 Spring Seat

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Figure 2—Tie Rod End

FRONT AXLE REPAIR

TIE ROD REMOVAL AND DISASSEMBLY (Fig. 2)

1. Remove cotter pins and nuts (5) from tie rod end studs, support steering arm to prevent bending, then drive tie rod end tapered stud (6) out of steering arm. Remove spring (3), dust seal retainer (8), seal (7), and washer (2) from stud.

2. Loosen clamp bolts (10), then remove tie rod end assembly from tie rod (11).

3. Pry end plug lock ring (15) out of groove in end (13); then remove plug (16), seat and spring (17 and 18), and grease seal (14). Stud (6) and bearing (9) assembly can now be removed from body.

INSPECTION

Clean all parts of tie rod and then inspect parts for wear and check tension of spring (17, fig. 2). Discard worn parts and replace spring if broken or weak.

TIE ROD ASSEMBLY AND INSTALLATION (Fig. 2)

1. Lubricate parts with lubricant specified in LUBRICATION (SEC. 13) before assembling tie rod ends.

2. Insert end stud (6) and bearing (9) into tie rod end (13). Place grease seal (14) over end of spring seat (18); position seat in tie rod end (13).

3. Place stud seat spring (17) inside seat (18), lay retaining plug (16) on spring, then compress spring (17) and install lock ring (15) in groove in tie rod end (13).

4. Thread tie rod end assemblies on tie rod (11), install clamp bolts (10), new lock washers, and nuts (12). Do not tighten nuts (12) at this time.

5. Carefully clean tapered portion of tie rod end studs (6), then install dust seal washer (2), dust seal (7), dust seal retainer (8), and dust seal spring (3) on end studs in order named.

6. Clean tapered holes in steering tie rod arms, position complete tie rod assembly on steering arms, then thread stud nut (5) on end stud (6). Tighten stud nuts to minimum torque given in "Specifications" at end of this section, then tighten nuts until next castellation on nut lines up with cotter pin holes in studs. Install new cotter pin full size of hole.

FRONT AXLE SPECIFICATIONS

STEERING KNUCKLE	
Spindle Diameter	
At Inner Wheel Bearing	2.5613″-2.5623″
At Outer Wheel Bearing	2.1243″-2.1248″
Steering Knuckle Bushings	
Inner Diameter	1.7965″-1.7975″
Length	2.1775″-2.1975″
King Pin Bushings	
Inner Diameter	1.310″-1.311″
Outer Diameter	1.7930″-1.7940″
Length	2 15/32″
KING PIN	
Diameter at Top of Pin	1.3085″-1.3095″
Diameter at Bottom of Pin	1.7930″-1.7940″
Length (Overall)	10¾″
FITS AND TOLERANCES	
Clearance Between	
King Pin Bushing and Knuckle Bushing	0.0025″-0.0045″
King Pin and Lower Knuckle Bushing	0.0025″-0.0045″
FITS AND TOLERANCES (Cont.)	
King Pin and King Pin Bushing	0.001″-0.003″
Steering Knuckle Thrust	0.015″ Maximum
Thrust Adjustment	With Shims and Spacers
Shim Thickness Available—1 @	0.015″
Spacing Washer Thickness Available	0.093″, 0.125″, & 0.156″
TORQUE SPECIFICATIONS	
King Pin Nuts	350-390 ft.-lbs.
Steering Arm Nuts	350-390 ft.-lbs.
Tie Rod End Clamp Bolt Nuts	65-80 ft.-lbs.
Tie Rod End Stud Nuts	150 ft.-lbs. min., then advance to nearest cotter pin hole
TIE ROD END	
End Stud Seat Spring Free Length	1¼″
Resistance When Compressed to ⅞″	225-275 lbs.
Solid Height	13/16″
AXLE CENTER	
Maximum Allowable Twist End to End	½°

Rear Axle

DESCRIPTION

Rear axle is a full-floating type, using a one-piece axle housing with housing bowl cover welded to housing. Housing bowl is located to the right of vehicle center line.

Drive pinion assembly, as shown in figure 4, is mounted at an angle to drive gear, thus increasing the tooth contact area between drive gear and drive pinion gear teeth. Drive is transmitted from transmission angle drive unit through a propeller shaft to spiral bevel gears, axle housing, and then to vehicle underframe through upper and lower radius rods.

Differential and drive pinion assemblies are both provided with facilities for adjustment of bearings and gear tooth contact.

DIFFERENTIAL CARRIER

Differential assembly, drive pinion, and pinion cage assembly are mounted in differential carrier. After axle shafts have been removed and propeller shaft has been disconnected, differential carrier can be removed for inspection and adjustment without removing axle housing from vehicle.

DIFFERENTIAL ASSEMBLY

Differential is a conventional four-pinion type, carried in a two-piece case mounted on tapered roller bearings. Bevel drive gear is bolted to flanged half of differential case. Drive gear and pinion are furnished in matched, lapped sets, and should always be installed as such to assure satisfactory operation.

Thrust washers are used between differential side gears and case, also between differential pinions and case. Differential case halves are held together with special bolts and slotted nuts, locked in place with lock wire.

DIFFERENTIAL SIDE BEARINGS

Differential is supported in tapered roller bearings which take thrust as well as radial loads. Bearings are mounted in machined supports in differential carrier, with thrust loads taken by adjusting rings threaded into carrier supports and bearing caps. Adjusting rings bear against bearing cups and are locked in position by adjusting ring locks bolted to each bearing cap.

PINION AND CAGE ASSEMBLY

Bevel drive pinion is installed at an angle in differential carrier. Pinion is straddle mounted in two opposed tapered roller bearings at outer end, and one straight roller bearing at inner end.

Tapered roller bearing cups installed in pinion cage are separated by a machined shoulder in pinion cage.

Spacer of correct thickness is used to adjust pinion bearings on shaft.

Straight roller bearing at inner end of drive pinion is secured in place with a retainer ring.

Shims of various thicknesses are used between pinion cage and differential carrier to adjust drive pinion tooth contact and gear backlash.

Pinion shaft and cage assembly cannot be removed from carrier until differential assembly has been removed from carrier.

AXLE SHAFTS AND HOUSING

Axle shafts are full floating type. Drive flange at outer end is attached to hub by studs, nuts, and tapered dowels; inner end of shaft is splined to differential side gear.

Axle housing is a one-piece design with differential bowl located off center. Housing is equipped with outer end tubes which are threaded to accommodate wheel bearing adjusting nuts.

MAINTENANCE ON VEHICLE

The following maintenance operations should be accomplished at regular inspection and lubrication intervals.

LUBRICATION

Lubrication checking and draining intervals and filling instructions, also type of lubricant and capacity is given in LUBRICATION (SEC. 13).

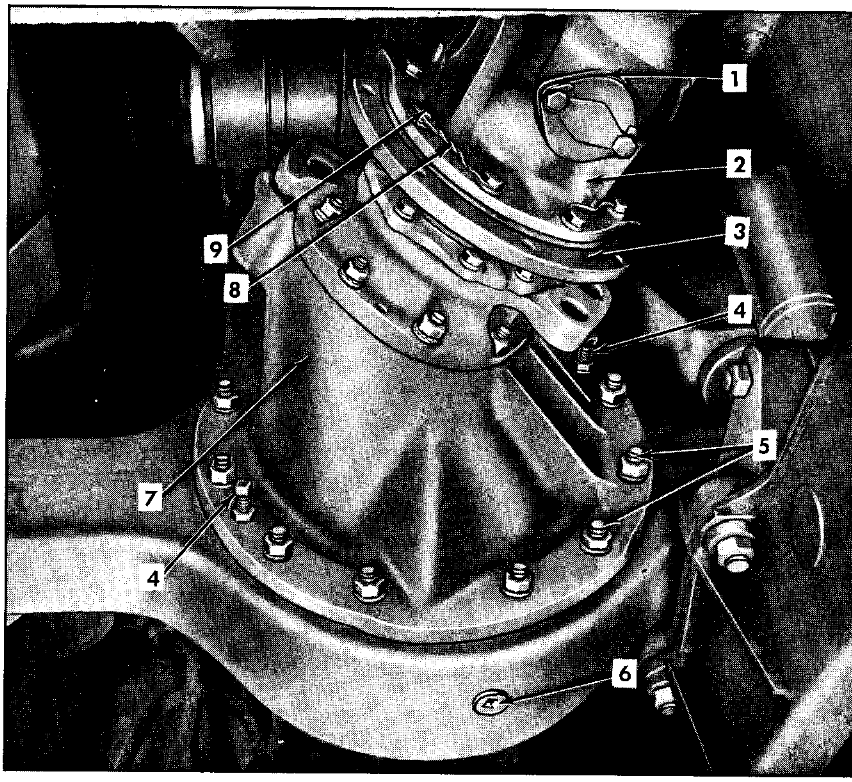
Examine pinion oil seal, axle shaft flange and carrier to housing gaskets for evidence of lubricant leakage. Tighten bolts or nuts, or replace gaskets and seals to correct leaks.

MOUNTING

Maintenance of axle mounting on vehicle consists primarily of a regular and systematic inspection of air suspension units and radius rods as directed in AIR SUSPENSION (SEC. 14).

AXLE SHAFT AND PINION CAGE MOUNTING

Axle shafts and pinion cage are retained with stud nuts, lock washers, and split tapered dowels. The studs must be straight and dowels of correct taper must be used. There should always be a slight clearance between nuts and mounting flange when nuts are tight.



1 Universal Joint
2 Universal Joint Flange Yoke
3 Drive Pinion Companion Flange
4 Pusher Screws
5 Carrier-to-Housing Stud
6 Drain Plug
7 Differential Carrier Assembly
8 Lock Wire
9 Bolt

T-2202

Figure 1—Rear Axle and Differential Carrier Installed

Whenever inspection shows that no clearance exists between nut and flange, this indicates that excessive wear exists at tapered dowels, studs, or tapered holes in drive flange.

If stud nuts are not tightened to recommended torque, play at flange and broken or worn studs will result and damaged parts must be replaced.

REAR AXLE REPLACEMENT

Complete instructions for removal and installation of rear axle assembly will be found in AIR SUSPENSION (SEC. 14).

DIFFERENTIAL CARRIER REPLACEMENT (WITH AXLE IN VEHICLE)

(Key Numbers in Text Refer to Figure 1)

Due to limited space between rear axle and bulkhead, the following procedures are necessary to remove and install the differential carrier with axle installed under vehicle.

REMOVAL

1. Place rear wheels of coach on 10-inch riser blocks, keeping blocks flush with inside of rear wheels. Block front wheels securely, FORE and AFT, to prevent vehicle rolling.
2. Remove both rear axle shafts as instructed under "Axle Shaft Replacement" in this section.
3. Remove drain plug (6) and drain lubricant from the axle housing.
4. Disconnect propeller shaft universal joint (1) from flange yoke at axle, referring to PROPELLER SHAFT (SEC. 18) in this manual. Wire shaft to body understructure to obtain maximum clearance.
5. Remove lock wires (8), bolts (9), and lock washers attaching universal joint flange yoke (2) to drive pinion companion flange. Remove flange yoke.
6. Remove nut from bolt attaching each rear height control valve link to bracket at bellows support. Disengage link bolt from bracket.
7. Lift up on both height control valve levers to admit air pressure into the rear suspension bellows. Hold levers up until coach body has raised sufficiently to permit installing a 10-inch safety spacer between body and axle at each side. Spacers can be made from steel tubing of sufficient diameter to fit over the axle bumpers. After installing safety spacers, pull down on both height control valve levers to exhaust air pressure from bellows, permitting coach body to rest on safety spacers.
8. Remove nuts and lock washers from studs

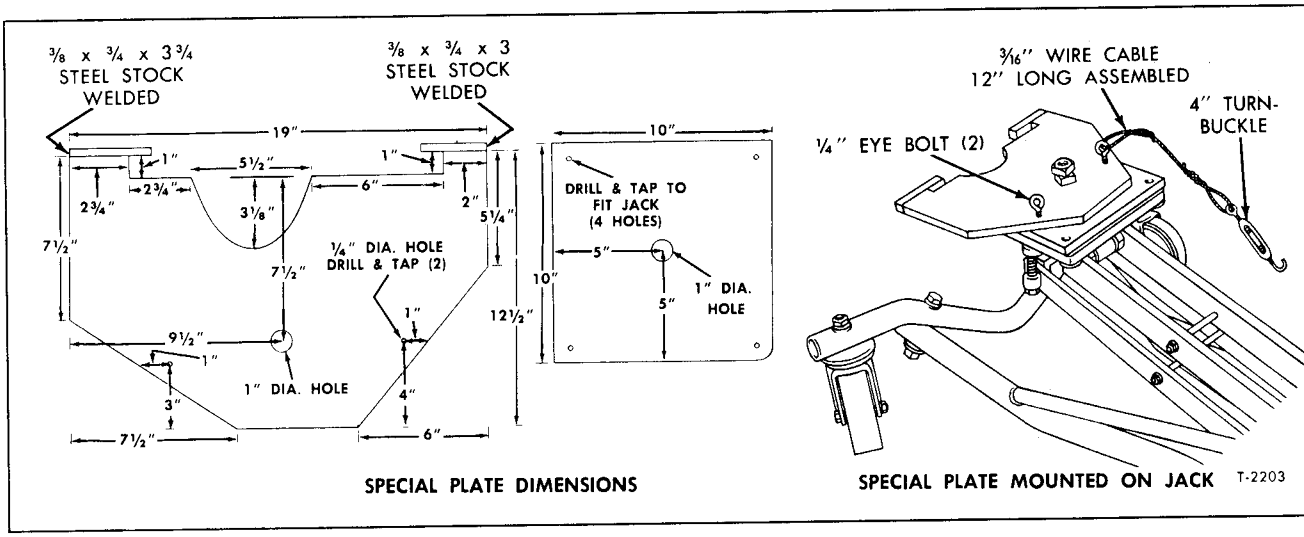


Figure 2—Special Jack Adapter Plates for Removing Differential Carrier

(5) attaching differential carrier to axle housing. Remove all lower studs from housing, using a suitable stud remover.

9. Loosen lock nuts on two carrier-to-housing pusher screws (4). Turn screws in to start carrier out of housing.

10. A floor model dolly jack, adapted for removing the differential assembly, should be positioned under the coach. An adapter plate should be fabricated locally, using a 3/4-inch flat steel plate and shaped to fit the lower portion of the differential carrier assembly.

A second 3/4-inch flat steel plate must be fabricated to fasten to the floor jack and adapter plate to permit rotation of the adapter plate. Refer to figure 2.

11. Pull the carrier assembly back as far as possible. Tilt the gear end of the carrier assembly up until it clears the yoke. As the carrier is moved out of the housing, move it down and to the left to clear all obstructions.

INSTALLATION

1. Before reinstalling the carrier assembly, clean mating surfaces of carrier flange and axle housing.

2. Make sure the carrier-to-housing pusher screws (4) are backed out so ends of screws will not interfere with carrier-to-housing contact. Secure screws with lock nuts.

3. Mount the carrier assembly on the floor jack using the same base plate and adapter plate used to remove the carrier. Use wire or string to secure a new gasket to the carrier flange until the carrier can be positioned in the axle housing.

4. With the carrier securely supported on the floor jack, roll under vehicle and maneuver into position at axle housing. Start carrier into housing until studs extend through the carrier flange. Remove wire or string used to attach the gasket to the carrier flange and transfer gasket to the studs of the housing. Use flat washers and nuts on four evenly spaced studs to draw carrier squarely into the housing.

5. Reinstall carrier studs in lower half of the axle housing. Seat studs firmly, using a suitable stud replacer.

6. Remove nuts and flat washers used to draw carrier into position, then install lock washers and nuts on all studs.

7. Tighten nuts to recommended torque value listed in "Specifications" at end of this section.

8. Install universal joint flange yoke (2) on drive pinion companion flange (3) and attach with bolts (9), lock washers, and nuts. Nuts must be on axle side of companion flange, with the lock washers under bolt heads. Tighten firmly, then thread lock wires (8) through adjacent pairs of bolt heads and twist ends of each wire together.

9. Connect propeller shaft to flange yoke at axle by assembling universal joint as directed in PROPELLER SHAFT (SEC. 18).

10. Install drain plug (7) in axle housing and tighten firmly. Fill axle housing with lubricant, and lubricate propeller shaft universal joints as directed in LUBRICATION (SEC. 13).

11. Push up on both height control valve levers to admit air pressure into bellows. Hold levers up until coach body has risen enough to permit removal of safety spacers. Remove spacers.

12. Insert the height control valve link bolts through holes in brackets and secure with self-locking nuts. Tighten nuts to recommended torque value listed in "Specifications" at end of this section.

13. Install axle shafts as directed under "Axle Shaft Replacement" in this section.

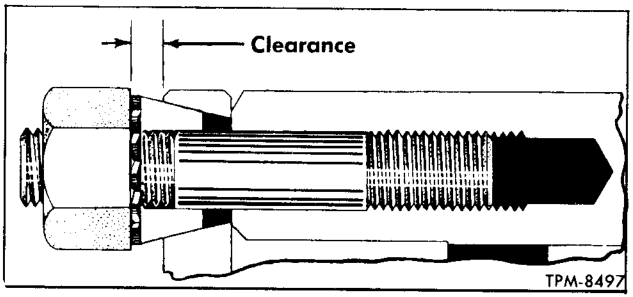


Figure 3—Clearance Between Nut and Flange

AXLE SHAFT REPLACEMENT

The following procedure for removal and installation of axle shaft is applicable regardless whether the axle assembly is removed or installed on the vehicle.

REMOVAL

1. Remove nuts and washers from hub studs.
2. Strike center of flange with a lead hammer to loosen flange and dowels from studs.
3. Withdraw axle shaft from housing, then remove gasket from hub or flange.

NOTE: Three threaded holes are provided in axle shaft flange for use of puller screws, if necessary.

INSTALLATION

1. Before installing axle shafts, hubs should be removed and bearings cleaned, inspected, and adjusted as directed in "HUBS AND BEARINGS" (SEC. 19).
2. Install new gasket over hub studs. NOTE: Observe that oil seal wiper is in place on outer end of axle housing tube and oil seal assembly is in place on hub studs.
3. Dip splined end of axle shaft in rear axle lubricant, then insert shaft into housing, guiding shaft into side gear and at same time align flange holes with hub studs. When studs and flange holes are in alignment, push axle shaft into place.
4. Install split tapered dowels, external-toothed lock washers, and nuts on four studs at tapered holes in flange; also install lock washers and nuts at remaining six studs. Tighten nuts alternately and evenly to recommended torque value listed in "Specifications" at end of this section.
5. Observe that clearance exists between nut and flange (fig. 3). If no clearance exists, this indicates excessive wear at studs, dowels, or flange holes. Replace worn parts if necessary.

AXLE OVERHAUL

DISASSEMBLY

Rear axle may be disassembled while housing remains installed in vehicle if proper equipment is available for handling differential assembly. Information on suspension, propeller shaft, brakes, hubs, bearings, wheels, and tires will be found in respective sections of this manual.

The following instructions provide procedures for complete disassembly, cleaning, inspection, repair, and reassembly of rear axle. Axle housing may be checked for bent condition before axle assembly is removed from coach. The following repair procedure is based on the operations neces-

1 Drive Gear	18 Pinion Cage Tapered Dowel	33 Pinion Bearing Spacer
2 Differential Case	19 Lock Washer	34 Pinion Bearing Cup - Inner
3 Differential Spider	20 Stud Nut	35 Pinion Bearing Cone - Inner
4 Pinion Thrust Washer	21 Pinion Cage Stud	36 Drive Pinion
5 Case Bolt Nut	22 Pinion Oil Seal Retainer Gasket	37 Pinion Bearing
6 Adjusting Ring Lock	23 Pinion Oil Seal Retainer	38 Bearing Retainer Ring
7 Lock Bolt	24 Oil Seal Sleeve	39 Carrier Stud
8 Bearing Adjusting Ring	25 Pinion Nut	40 Stud Nut
9 Axle Shaft (Right)	26 Pinion Nut Washer	41 Lock Washer
10 Axle Housing	27 Propeller Shaft Companion Flange	42 Axle Shaft (Left)
11 Carrier Gasket	28 Dust Slinger	43 Differential Bearing Cone
12 Side Gear Thrust Washer	29 Pinion Oil Seal Assembly	44 Differential Bearing Cup
13 Differential Side Gear	30 Pinion Cage	45 Differential Bearing Cap
14 Bolt Lock Wire	31 Pinion Bearing Cone - Outer	46 Differential Bearing Cap Stud
15 Drive Gear Bolt	32 Pinion Bearing Cup - Outer	47 Differential Bearing Cap Nut
16 Differential Carrier		48 Differential Pinion
17 Pinion Cage Shims		49 Differential Case Bolt

Captions for Figure 4—Opposite Page

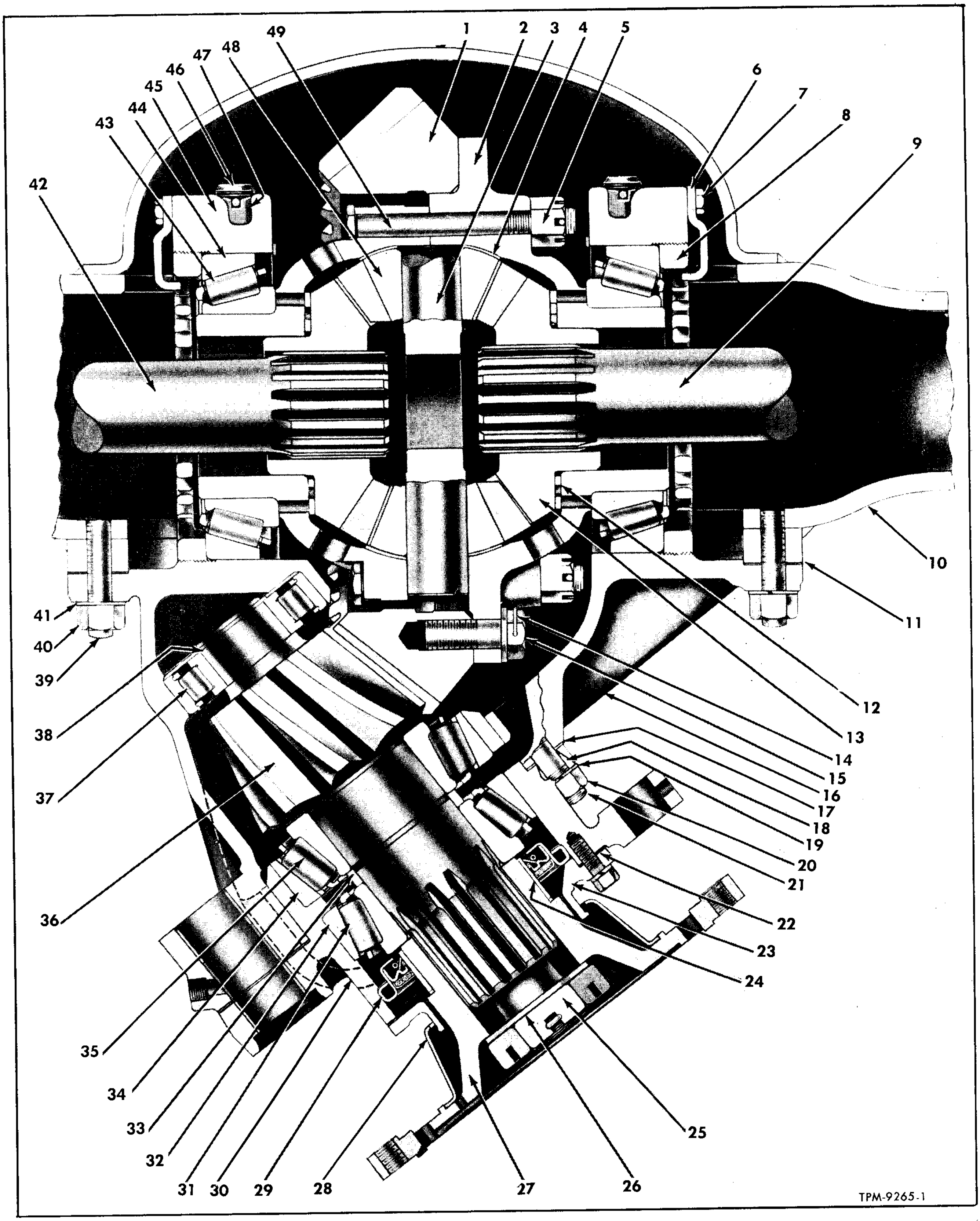


Figure 4—Sectional View of Rear Axle

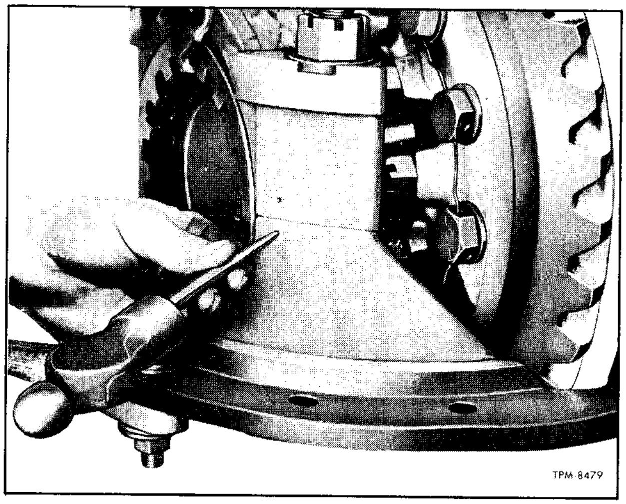


Figure 5—Bearing Cap Alignment Marks

sary when axle is removed from coach.

Before and during disassembly operations, perform following inspections and check all adjustments to determine repairs required.

Key numbers in text refer to figure 4 unless otherwise indicated.

AXLE HOUSING

At regular inspection intervals, or if conditions indicate that rear axle housing might be bent, housing should be checked, using the following method. This check can be made before or after axle is removed from coach to determine if axle housing is sprung. Conventional camber and toe-in gauges can be used to perform inspection.

1. Support axle in level position using blocks at each support beam; then check rear wheel bearings for proper adjustment as instructed in "HUBS AND BEARINGS" (SEC. 19).

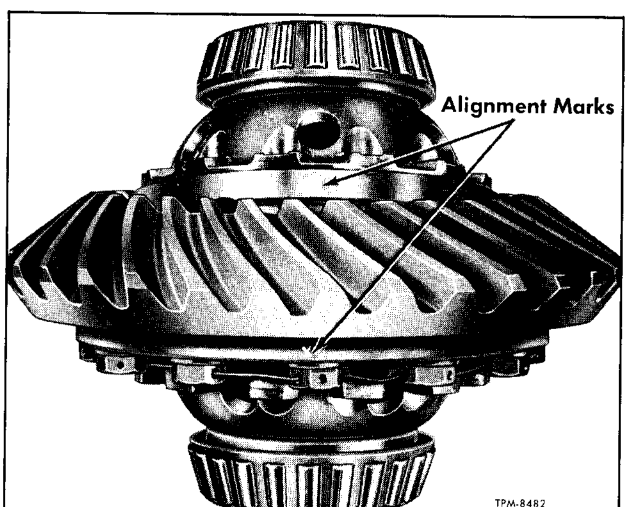


Figure 6—Differential Case Alignment Marks

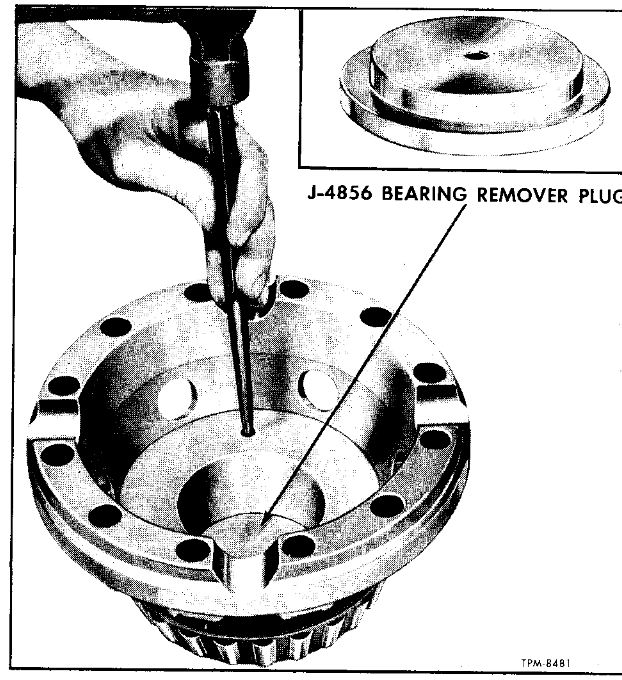


Figure 7—Differential Bearing Removal

2. Check run-out at each rear wheel and replace wheels having run-out in excess of 3/32".

3. Check for toe-in and camber at rear wheels. Rear wheels should not toe-in or out more than 1/8", and camber should be zero, plus or minus 1/4 degree. If measurements are not within the above dimensions, bent or sprung axle housing is indicated. Make notation of the existing conditions for use when making corrections later.

4. In cases where bent axle housings are indicated, further checks to determine exact location of bend should be made after differential carrier has been removed, then necessary steps taken to correct the condition.

DIFFERENTIAL CARRIER REMOVAL

1. Remove axle shafts as previously instructed under "Axle Shaft Replacement" in this section.

2. Remove drain plug (7, fig. 1) and drain lubricant from housing.

3. Remove stud nuts (40) and lock washers (41) from differential carrier studs (39).

4. Be certain that differential carrier is supported securely, then proceed to pull complete carrier assembly out of housing. A small pinch bar may be used to keep carrier straight in housing bore while carrier is being withdrawn, provided end of bar is rounded to prevent damage to carrier flange.

DIFFERENTIAL REMOVAL

1. Remove lock wire from adjusting ring lock retaining bolts (7), then remove locks (6).

2. Remove wires and nuts (47) from differential side bearing cap studs (46). Make certain that bearing caps (45) and carrier are marked (fig. 5) before removal, then remove side bearing caps (45). Remove side bearing adjusting rings (8). Lift differential assembly with cups (44) from carrier. Remove bearing cups (44) from bearings (43).

DIFFERENTIAL DISASSEMBLY

1. Mark both halves of differential case (2) so halves may be reassembled in original positions (fig. 6).
2. Remove lock wire and nuts (5) from bolts (49) which hold the two halves of differential case (2) together; then separate halves of case.
3. Remove side gears (13), thrust washers (12), spider (3), pinions (48), and thrust washers (4) from differential case.
4. Using differential bearing remover plug (J-4856) as shown in figure 7, drive bearing evenly off each differential case half, using a long punch and hammer as illustrated.
5. Remove lock wire (14) from cap screws (15), then remove cap screws holding drive gear (1) to differential case. Remove gear from case.

PINION CAGE REMOVAL AND DISASSEMBLY

1. Remove nuts (20) and lock washers (19) which secure pinion cage (30) to differential carrier (16). Tap pinion cage to loosen and remove four tapered dowels (18).
2. Install two puller screws (1/2"-13 x 1-1/2") and tighten alternately and evenly to pull cage (30) out of carrier. Remove shim pack (17) from pinion cage studs (21). Tie shims (17) together so same shim pack may be used at reassembly.
3. Remove retainer ring (38) which secures inner bearing (37) on drive pinion (36); then remove inner bearing from drive pinion using universal puller (J-8176) and arbor press in manner illustrated in figure 8.
4. Clamp pinion in vise equipped with soft jaw plates. Remove cotter pin, nut (25), and washer (26) from drive pinion (36).
5. Using suitable puller, remove propeller shaft companion flange (27) from drive pinion (36).
6. Remove cap screws and lock washers from pinion oil seal retainer (23), then remove retainer and gasket.
7. Place cage and drive pinion assembly in an arbor press and press drive pinion (36) out of flange (27) and pinion cage. Outer bearing (30) will remain in pinion cage.
8. Remove bearing adjusting spacer (33) from drive pinion (36) and tag for reassembly reference.
9. If necessary, inner bearing cone (31) can be removed from pinion with universal puller (J-8176) and arbor press as illustrated in figure 8.

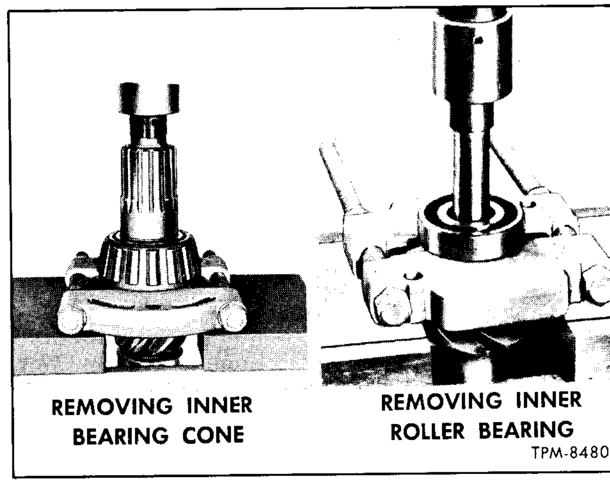


Figure 8—Pinion Bearing Removal

10. Remove oil seal (29) assembly from pinion cage.
11. When inspection indicates necessity, cups (32 and 34) can be removed from cage, using remover (J-3940) in manner illustrated in figure 9.

CLEANING, INSPECTION, AND REPAIR

(Key Numbers in Text Refer to Figure 4)

CLEANING BEARINGS

The importance of proper bearing cleaning cannot be over-emphasized. Bearings should al-

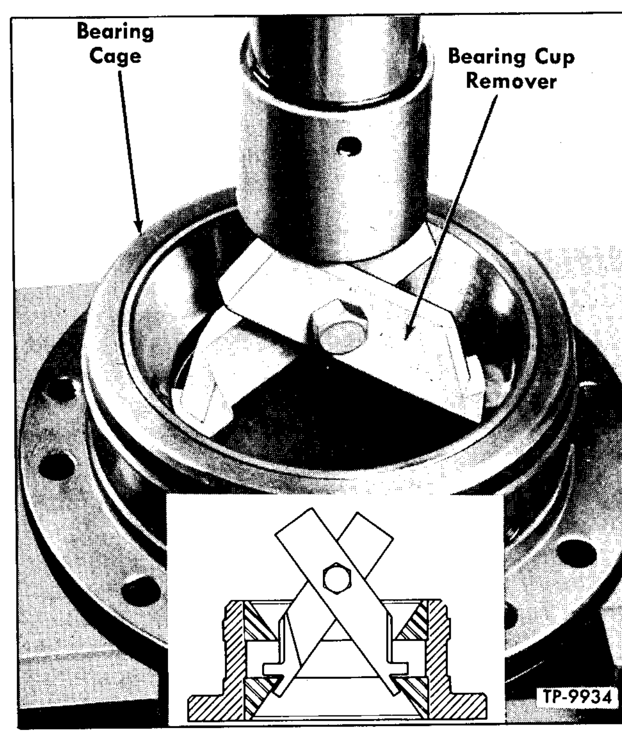


Figure 9—Pinion Cage Bearing Cup Removal

ways be cleaned separately from other rear axle parts. When cleaning bearings, be sure to perform all of the following steps:

1. Soak differential and drive pinion bearings in clean kerosene, Diesel fuel oil, or other cleaning solvent. Gasoline should not be used as a bearing cleaner. Also, bearings should never be placed in a hot solution tank for cleaning.

2. After old lubricant is loosened, hold bearing races so that bearings cannot rotate, then brush bearings with soft bristled brush until all grit and dirt has been removed.

3. Rinse bearings in clean fluid; then, while holding races, blow dry with compressed air. Be sure air stream is moisture free.

4. Inspect bearings as instructed under "Inspection Operations" later in this section. If bearings pass inspection, dip bearings in differential lubricant recommended in LUBRICATION (SEC. 13); then wrap bearings in clean cloth or paper until ready to reassemble axle.

CLEANING PARTS

Immerse all parts in suitable cleaning fluid and clean parts thoroughly. Use a stiff bristle brush to remove all old lubricant. Remove particles of gaskets which may adhere to mating faces of axle housing, differential carrier, hubs, and axle shaft flanges. Clean out lubricant channels in pinion cage and differential carrier. Clean housing breather. Make certain that interior of axle housing is thoroughly cleaned.

INSPECTION

Whenever available, the Magna-Flux method should be used on all steel parts, except ball and roller bearings. This method is especailly suited for inspection of ground or highly finished surfaces for wear and cracks which otherwise would not be visible.

INSPECTION OPERATIONS

1. Bearings. Rotate each bearing slowly, and at the same time examine bearing for roughness, damage, defects, or wear. Note condition of bearing cage. Replace bearing if cage is damaged or if any of the conditions previously noted exist.

2. Gears. Examine drive gear, drive pinion, and differential gears for damaged teeth, worn spots in surface hardening, and distortion. If either drive gear (1) or drive pinion (36) are worn or damaged, both must be replaced as a matched set. Never replace drive pinion or drive gear separately. Check differential pinions (48) for excessive wear, and fit on spider (3). Refer to "Specifications" at end of this section for limits. Check radial clearance between differential side gear hubs and differential case.

3. Differential Case. Inspect differential case assembly (2) for cracks, distortion, or damage. If case is in good condition, thoroughly clean case and cover; then assemble case with bolts and mount in lathe centers or "V" block stand. If lathe is not available, install differential side bearings and mount case in differential carrier as directed under "Differential Assembly Installation" later in this section. Install dial indicator and check differential case run-out. Refer to "Specifications" at end of this section for run-out limits. Whenever run-out exceeds limits, differential case run-out may be corrected as later described under "Repair" in this section.

4. Axle Shafts. Examine splined end of axle shaft (9 and 42) for twisted or cracked splines, twisted shaft, or damaged flange. If any of above conditions are evident, install new axle shafts.

5. Axle Shaft and Flange Run-Out. Install axle shaft assembly in lathe centers or "V" blocks. Check shaft run-out with dial indicator; if run-out exceeds limits listed in "Specifications" at end of this section, discard axle shaft. Position dial indicator so that indicator shaft end contacts inner surface of flange near outer edge, then check flange run-out. If run-out exceeds limits listed in "Specifications" at end of this section, discard axle shaft.

6. Axle Housing. If check made prior to disassembly of axle indicated a bent condition at axle housing (10), make more complete check of housing on surface plate to determine extent of damage. If inspection indicates a sprung or bent condition, axle housing should be discarded. Straightening of axle forgings is not a recommended operation.

7. Oil Seal. Replacement of oil seal (29) when unit is disassembled is more economical than premature overhaul to replace this part at a future time. Further loss of lubricant through a worn seal may result in failure of other parts, such as gears and bearings.

Handle seal carefully, particularly when being installed. Cutting, scratching or curling under of lip of seal seriously impairs efficiency of seal. Use of Permatex or equivalent around outer diameter of seal is recommended to insure against leakage at this point.

8. Oil Seal Sleeve. Carefully inspect oil seal sleeve (24) at propeller shaft companion flange for any pitted, corroded, or worn condition at oil seal contact surface. If such imperfections cannot be cleaned up by polishing, the sleeve must be replaced.

REPAIR

1. Differential Case. Excessive run-out on differential case may be corrected by machining flange on gear side of case. Remove sufficient metal

from flange to correct excessive run-out. Metal must be cut on a true plane, removing just enough metal to bring run-out within limits listed in "Specifications" at end of this section. After differential case has been machined, remove burrs and clean case assembly thoroughly.

2. Propeller Shaft Flange Sleeve. Whenever inspection indicates that oil seal contact surface of sleeve on propeller shaft flange is corroded or pitted, the condition may be corrected by cleaning and polishing surface with a suitable abrasive cloth. If cleaning and polishing surface of sleeve does not clear up the condition, remove sleeve and install new part.

AXLE ASSEMBLY

After all parts have been thoroughly cleaned, apply a thin coating of differential lubricant, as specified in LUBRICATION (SEC. 13), on all thrust and bearing surfaces. Coating parts will prevent scoring when vehicle is first placed in service.

Use of new lock washers, gaskets, and oil seals is recommended during assembly of axle.

All adjustments given in assembly procedures must be made carefully to insure efficient and continuous axle operation.

Key numbers in text refer to figure 4.

DRIVE PINION AND CAGE ASSEMBLY

1. If pinion bearing cups (32 and 34) were removed during disassembly, press bearing cups firmly against shoulder of pinion bearing cage (30).
2. Position pinion bearing (35) on drive pinion (36), with widest part of bearing cone toward gear teeth, then press bearing on pinion until bearing cone is seated solidly on drive pinion.
3. Install drive pinion inner bearing (37) on drive pinion (36), using arbor press. Install retainer ring (38) to retain bearing.
4. Lubricate pinion bearing cones and cups. Install original pinion bearing adjusting spacer (33) on drive pinion.
5. Insert drive pinion (36) and bearing assembly into pinion cage (30); then using an arbor press, press outer pinion bearing (31) firmly against bearing spacer (33). Rotate bearing cage through several complete revolutions to assure normal bearing contact.
6. While assembly is still in press under pressure (14-ton), check drive pinion bearing preload. Wrap soft wire around pinion bearing cage (30) as shown in figure 10. Attach pound scale to wire, then pull on scale, keeping scale in a horizontal plane. Note scale reading when assembly is rotating freely. Reading should be from 5 to 15 inch-pounds. To compute inch-pound value of scale reading, multiply scale reading (pounds) by one-half pinion cage diameter (inches). If reading does not fall between limits given, use thinner spacer (33) to increase or thicker spacer to decrease pinion bearing preload. Spacer thicknesses available are given in "Specifications" at end of this section.

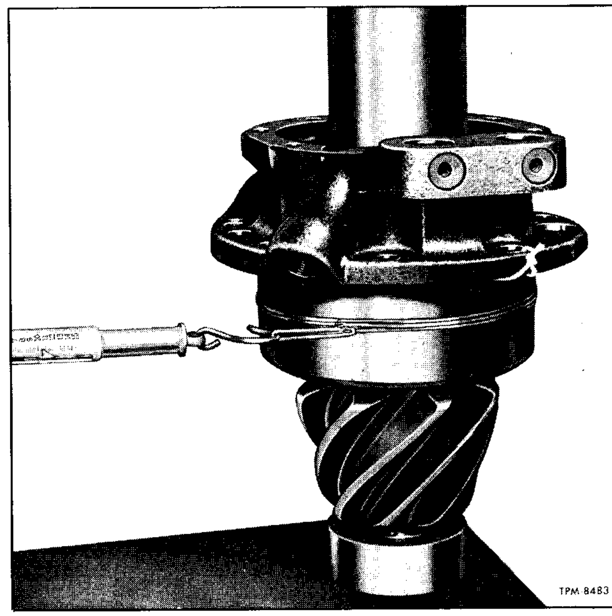


Figure 10—Checking Pinion Bearing Preload

NOTE: If arbor press is not available, temporarily install propeller shaft flange (27), washer (26), and nut (25). Tighten nut to 800-1100 foot-pounds torque, then check pinion bearing preload as directed in preceding paragraph. Remove nut, washer, and flange after adjustment.

7. Lubricate oil seal assembly (29) and cover outer edge of seal body with a non-hardening sealing compound; then install oil seal in cage, being careful that it is straight and is seated against shoulder in cage.
8. Install oil slinger (23) to cage, using new gasket (22). Install and tighten cap screws.
9. Using arbor press, press propeller shaft companion flange onto drive pinion.
10. Place washer (26) on drive pinion (36), then install nut (25). Tighten nut to minimum torque listed in "Specifications" at end of this section, then tighten nut until next castellation in nut lines up with cotter pin hole in drive pinion and install cotter pin.

DRIVE PINION INSTALLATION

1. Lubricate drive pinion bearings with rear axle lubricant recommended in LUBRICATION (SEC. 13).
2. Place original pinion cage shims (17) over pinion cage studs (21), then position drive pinion and cage assembly on studs (21).

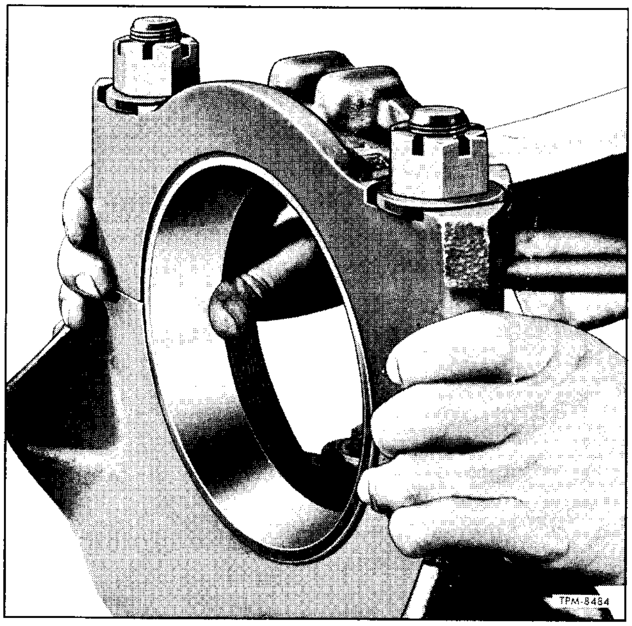


Figure 11—Checking Fit of Differential Bearing Cup

IMPORTANT: Oil holes in shims must line up with oil passages in differential carrier and cage when installed, to assure proper lubrication of drive pinion bearings (31 and 35).

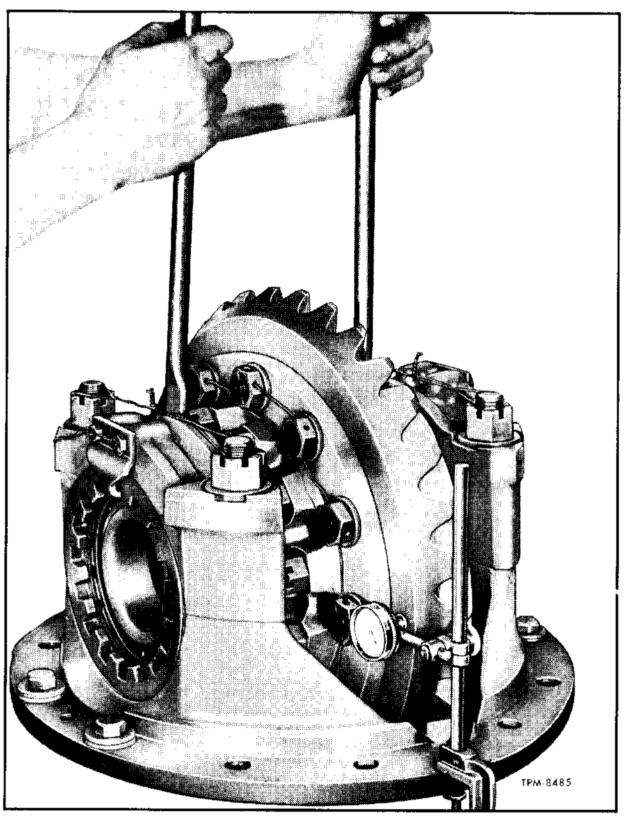


Figure 12—Differential Bearing Preload Check

3. Install new split tapered dowels (18), external-toothed lock washers and nuts at four studs, also lock washer and nut (20) at four remaining studs. Tighten nuts (20) to recommended torque value listed in "Specifications" at end of this section.

DIFFERENTIAL ASSEMBLY

After checking differential case run-out as previously described under "Cleaning, Inspection, and Repair" in this section, assemble differential as follows:

1. Lubricate differential case inner walls and all component parts of differential assembly with rear axle lubricant specified in LUBRICATION (SEC. 13).

2. Using an arbor press, press differential bearing cones (43) on differential case, making sure cones seat firmly against shoulder of case.

3. Using alignment marks that were made at disassembly, position flanged side of differential case on bevel gear (1). Install washers and bolts (15), and tighten bolts to recommended torque value listed in "Specifications" at end of this section. Install lock wire (14) in such a manner that lock wire will become tighter if bolts should work loose.

4. Position side gear thrust washer (12) on hub of side gear (13), then place gear in flanged half of differential case (2).

5. Lay flanged half of case on bench with flange upward, place differential pinions (46) and pinion thrust washers (4) on differential spider (3), place pinion and spider assembly on side gear (13) previously installed, then install remaining side gear (13) and thrust washer (12).

6. Place plain half of differential case on opposite half, with alignment marks positioned as shown in figure 6. Install case bolts (49) downward through both halves of case.

7. Install nuts (5) on four equally spaced bolts (49), and tighten to recommended torque value listed in "Specifications" at end of this section. Check assembly for free rotation. If rotation is free and smooth, install remaining bolts and nuts and tighten to recommended torque.

DIFFERENTIAL ASSEMBLY INSTALLATION

Proper bearing cup and adjusting ring fit is of utmost importance and should be carefully checked before differential is installed.

1. Temporarily install bearing cup (44), adjuster ring (8), and bearing cap (45), then tighten stud nuts (47) to recommended torque.

2. Bearing cup must be a hand push fit (fig. 11) in bore, otherwise the bore must be reworked with a scraper or emery cloth until proper fit is obtained. Location of high spots in carrier bore can be readily located by applying a light coating of prussian blue to bearing cup.

3. If adjusting ring cannot be turned by hand or with a maximum of 20 foot-pounds torque, this indicates that ring may be oversize and another ring that provides proper fit should be used.

4. Coat differential side bearing cones and cups with rear axle lubricant specified in LUBRICATION (SEC. 13).

5. Place bearing cups (44) over bearing cones (43), then position differential assembly in differential carrier.

6. Place differential bearing caps (45) over studs with alignment marks in line (fig. 5), then tap lightly into position.

7. Insert bearing adjusting rings (8) and turn hand-tight against bearing cups (44).

8. Install nuts (47) on bearing cap studs, tighten nuts to recommended torque value listed in "Specifications" at end of this section.

9. Tighten adjusting rings (8) alternately until tight. Revolve differential assembly after each tightening to assure normal bearing contact and to keep bearing cups straight in bores.

DIFFERENTIAL BEARING PRELOAD ADJUSTMENT

1. Using dial indicator at back face of drive gear (1) as shown in figure 12, loosen bearing adjusting ring (8) on flanged side enough to notice end play on dial indicator.

2. Tighten the same adjusting ring until zero end play is obtained.

3. Tighten both adjusting rings (8) one notch each from zero end play position to impose correct preload on differential side bearings.

NOTE: After adjusting bearing preload, proceed with tooth contact and backlash adjustment as directed in following paragraph:

GEAR TOOTH CONTACT ADJUSTMENT

Drive pinion (36) is adjusted for tooth contact by means of shims (17) between pinion cage (30) and differential carrier (16). Drive gear (1) is adjusted by means of adjusting rings (8).

If original gears are reinstalled in assembly, painting gear teeth will not indicate the same contact as new gears and can be misleading. Gears that have been in service for extensive periods form running contacts due to wear on teeth. Therefore, the original shim pack (17) plus one 0.005" shim should be maintained to check backlash.

In the event that backlash exceeds maximum tolerances, reduce backlash only in the amount that will avoid overlap of worn teeth (fig. 13).

When new gears are to be installed, differential bearings and drive pinion bearings must be in proper adjustment before any attempt is made to adjust backlash. Check backlash with dial indicator as shown in figure 14, and adjust to value listed in "Specifications" at end of this section. Adjust backlash and tooth contact in the following manner:

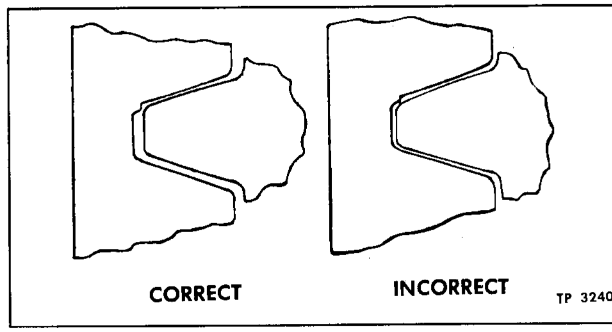


Figure 13—Worn Tooth Cross Section

1. Paint at least ten teeth of bevel gear with a mixture of red lead or prussian blue and engine oil. Rotate gears through a few revolutions in both directions by hand. Refer to gear tooth contact charts (fig. 15) for directions for making proper adjustments.

2. When satisfactory tooth contact and backlash has been obtained, install adjusting ring locks (6) and secure bolts (7) with lock wire.

DIFFERENTIAL CARRIER INSTALLATION

1. Clean flanges of differential carrier (16) and axle housing (10), then position new differential carrier gasket (11) on carrier studs (39).

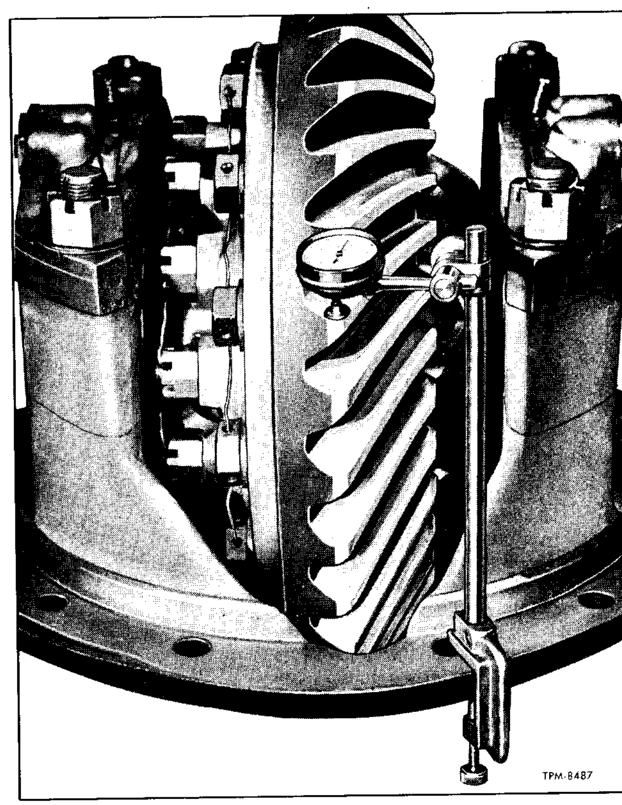
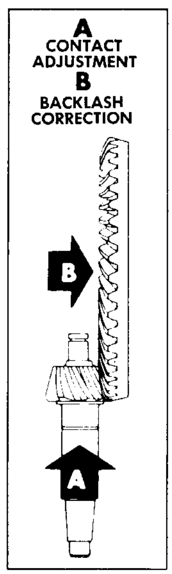


Figure 14—Gear Backlash Check

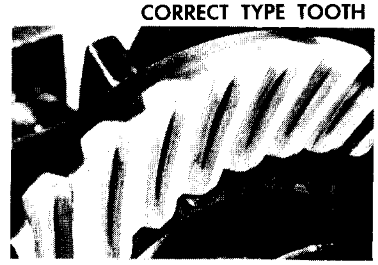
REAR AXLE

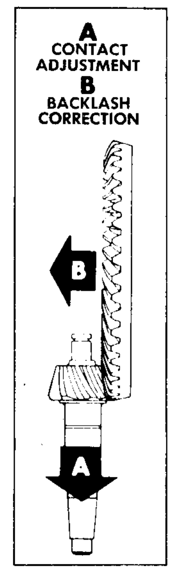
PAINTING GEAR TEETH

CORRECT TYPE TOOTH CONTACT

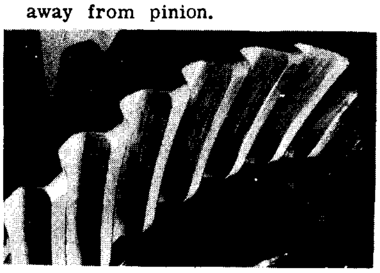


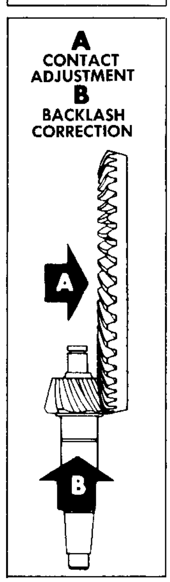
A HIGH NARROW CONTACT is not desirable. If gears are permitted to operate with an adjustment of this kind, noise, galling and rolling over of top edge of teeth will result. To obtain correct contact, move pinion toward bevel gear. This lowers contact area to proper location. This adjustment will decrease the backlash which may be corrected by moving bevel gear away from pinion.



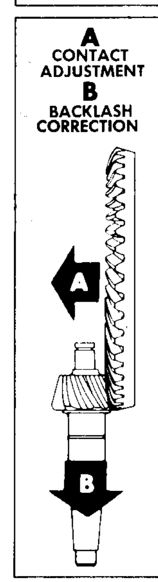


A LOW NARROW CONTACT is not desirable. If gears are permitted to operate with an adjustment of this type, galling, noise and grooving of teeth will result. To obtain correct contact, move pinion away from drive gear. This will raise contact area to proper location. A correct backlash is obtained by moving bevel gear toward pinion.





A SHORT TOE CONTACT is not desirable. If gears are permitted to operate with an adjustment of this type, chipping at tooth edges and excessive wear due to small contact area will result. To obtain correct contact, move drive gear from pinion. This will increase the lengthwise contact and move contact toward heel of tooth. Correct backlash is obtained by moving pinion toward bevel gear.



A SHORT HEEL CONTACT is not desirable. If gears are permitted to operate with an adjustment of this type, chipping, excessive wear and noise will result. To obtain correct contact, move drive gear toward pinion to increase lengthwise contact and move contact toward toe. A correct backlash is obtained by moving pinion away from drive gear.

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Figure 15—Tooth Contact Chart (Illustrations Are Typical)

2. Start carrier into housing using four flat washers and nuts (40) equally spaced, then tighten nuts alternately and evenly to draw carrier squarely into housing.

CAUTION: Driving carrier into axle housing by use of a steel hammer will not only damage carrier stud flange but will also cause oil leaks.

3. Remove nuts and flat washers, then install lock washers (41) and stud nuts. Tighten nuts to recommended torque value listed in "Specifications" at end of this section.

4. Install drain plug and tighten firmly. Fill axle housing to proper level with lubricant specified in LUBRICATION (SEC. 13). Install and tighten filler plug.

5. Install axle shafts as previously directed under "Axle Shaft Replacement" in this section.

REAR AXLE SPECIFICATIONS

TYPE	Angle Spiral Bevel
DRIVE	Radius Rods
RATIO	
Standard	4⅛ to 1"
ADJUSTMENTS AND CLEARANCES	
Drive Gear and Pinion Backlash	0.006"-0.012"
Adjustment Method	See Text
Shim Thickness (Carrier to Cage)	0.003"-0.005"-0.010"-0.020"
Pinion Bearings	
Adjustment Method	Selective Spacers
Spacer Thickness	0.187"-0.188"-0.190"-0.192"-0.194"-0.196"-0.198"-0.200"-0.201"-0.215"-0.229"
Rotating Torque (In. Lbs.)	5-15
Differential Bearings	
Adjustment Method	Threaded Adjusting Rings
Bearing Pre-Load	See Text
DIFFERENTIAL CASE	
Run-Out (Max.)	0.002"
SPIDER PINION	
Bore Diameter (Grind)	1.252"-1.254"
Clearance—Pinion to Spider	0.004"-0.008"
SPIDER	
Diameter of Arms	1.246"-1.248"
Arms in Same Plane Within	0.0025"
THRUST WASHER THICKNESS	
Side Gear	0.121"-0.125"
Spider Pinion	0.058"-0.062"
AXLE SHAFT	
Type	Full Floating
Drive Flange Run-Out (Max.)	0.005"
Shaft Run-Out at Center (Max.)	1/16"
Diameter at Splined End	2.372"-2.377"
TORQUE SPECIFICATIONS (Ft. Lbs.)	
Propeller Shaft Flange Nut (1¾-12)	800-1100
Pinion Cage Stud Nuts (½-20)	80-105
Carrier to Housing Stud Nuts (⅝-18)	185-205
Differential Case Bolt Nuts (⅝-18)	185-205
Differential Bearing Cap Stud Nuts (⅞-14)	375-415
Drive Gear Bolt (¾-16)	255-280
Adjusting Ring Lock Cap Screw (5⁄16-18)	15-20
Axle Shaft Flange Stud Nut (9⁄16-18)	103-113
Height Control Valve Link Nuts	5-7

Body

This group is divided into two sections covering "GENERAL BODY MAINTENANCE" and "LAVATORY."

General Body Maintenance

GENERAL MAINTENANCE

Unlike the conventional motor vehicles which have a separate frame, the coach body comprises the main structure of the vehicle. Body construction is basically aluminum, reinforced with steel components. Chassis units such as the power plant, axles and steering system, etc., are attached directly to the body.

The body framing and outer panels are constructed into a box-type unit which absorbs all the road shock, driving and braking stresses. A small amount of twist occurs in body, as complete rigidity of the structure is not desirable. It is, therefore, important that body be regularly inspected for loose rivets and bolts.

Entire vehicle should be regularly inspected for condition of paint and for corrosion damage, with particular attention given to underside. Inspection should be made more frequently in freezing weather due to the corrosive effect of road deicing materials (salt, calcium chloride, etc.) on metal. If inspection discloses any evidences of corrosion, paint failure, or bare metal, corrective measures as outlined under "Painting" (later in this section) should be immediately employed.

If fiberglass parts, such as the headlamp housings and front belt molding become damaged, they can be repaired as explained later under "Repair of Fiber Glass Parts."

EXTERIOR MAINTENANCE

Body painted surfaces and polished side moldings should be protected by a coating of wax, applied at regular intervals. Periods between applications should be sufficiently short to assure continuous protection of the finish. Any good body wax can be used for both painted and polished surfaces. Wax should be applied immediately after coach has been cleaned.

When necessary to remove previous wax coating, gasoline or similar solvents meeting local fire and health regulations may be employed.

Hard, anodized finish on side moldings is produced by an electrochemical process. Anodic coating is abrasion-resistant and may be cleaned, if necessary, with a mild abrasive cleaner. However, this finish, like other aluminum, is attached by many acids and most alkalies. Consequently, considerable care should be taken in the selection of chemical cleaners. Do not use an alkaline cleaner.

PAINTING

Aluminum corrodes just as iron and steel rusts. Under certain conditions aluminum will corrode more rapidly than steel. Inspect body surfaces regularly for corrosion and paint condition.

Only sound parts can be refinished. If rust or corrosion is excessive, replace with new parts. Remove old parts from body of coach. Refinish all exposed adjacent parts which remain on coach body. When installing new parts use only zinc or cadmium coated bolts, washers and nuts.

The instructions which follow cover both steel and aluminum parts and both new and old parts. Zinc coated metals are also covered by these instructions.

PAINTING NEW PARTS AND REPAINTING OLD PARTS

1. Thorough cleaning is essential; all corrosion, grease and other foreign matter must be removed. Solvent cleaning, pressure steam cleaning, wire brushing, and hand sanding methods are recommended.
2. Completely remove old paint by use of organic solvents. Do not use alkaline paint remover on aluminum. If old primer is very difficult to remove and there is no evidence of metal corrosion, old primer may be left on, but all loose paint must be removed.
3. Wipe the entire area to be refinished with cloths saturated with DuPont No. T-3812 reducer (or equivalent). Wipe dry.
4. Treat any scratched or abraded areas with DuPont No. VM-5717 metal conditioner (or equivalent) reduced one (1) part by volume with four (4) parts of water.

a. Apply the above mixture with a sponge or brush and allow to stand approximately three (3) minutes.

b. Wipe area with a damp cloth. Dry thoroughly.

5. Apply a coat of pre-primer (sometimes called wash-primer), preferably by spraying to a uniform and complete coverage coat on all surfaces. This type primer uses a special accelerating agent containing phosphoric acid which produces an excellent bond to metal. AP-10 or A-158 made by M & T Chemical Co., XE-5220 made by Bakelite Corporation, and 818-012 (2 parts) plus T8539 (1 part) made by DuPont, or any equivalent material made by a reputable paint manufacturer should be acceptable. These materials must be used within a few hours after addition of accelerator, therefore, directions of manufacturer should be observed carefully. Apply by spraying. Allow parts to dry.

6. Use a zinc chromate primer such as DuPont No. 63-150 or Pontiac Varnish Company's GMT-434, or any equivalent material made by a reputable manufacturer. Apply primer, preferably by spraying, to a minimum thickness of 0.5 mils. Allow parts to dry.

7. Apply finish coats:

a. For understructure and other parts not requiring color, apply a second coat of DuPont No. 63-150 or Pontiac Varnish Company's GMT-434, or equivalent.

b. To exposed body parts, apply desired color coats in accordance with standard practice.

c. Apply DuPont No. 181-65751 aluminum enamel top coat for final refinishing process in those areas where anodized aluminum panels are to be matched.

WASHING COACH INTERIORS

Tests conducted at the factory show that cleaning coach interiors with pressure spray equipment causes damage. The main kinds of damage are as follows:

1. CORROSION - in body panels at floor level, above and below floor. Also, floor separation results from excessive use of water.

2. SEAT DETERIORATION - Seams in Vinyl covered seats are made of cotton thread which rots and breaks when water soaked.

3. WATER IN ENGINE AIR INTAKE SYSTEM -- rear interior of coach is not water tight and water can drain down into the engine air intake system.

The only advantage in favor of pressure spray cleaning is time saving. This alone is not adequate reason to recommend this method. The recommended method is to sweep out debris, then wash areas which need cleaning with sponges and cloths. If necessary, use a mild soap which is not harmful to seats or interior finishes. Use water sparingly.

UNDERSTRUCTURE CORROSION PREVENTION

It is important to have a preventive maintenance program against salt corrosion. More salt is used on city streets and highways each year. Unless coaches are protected against this salt, rust and corrosion will be excessive. To prevent this, periodically clean the understructure to remove "dirt packs" from flanges, ledges, channels, etc. These places accumulate dirt and salt and hold it in direct contact with steel and aluminum surfaces. Use an understructure spray as part of a regular washing program with an occasional more thorough cleaning with a high pressure spray.

Frequent and careful inspection is also an important part of this preventive maintenance procedure. If any parts show evidence of rust or corrosion, treat as follows:

1. Clean. Remove dirt, grease, oil, etc., by solvent washing.

2. Remove corrosion and/or rust as well as all loose deadener coating by sanding, wire brushing or other mechanical means.

NOTE: If available, sand blasting can be used for cleaning bulkheads, brackets and other structural members; however, it should not be used for cleaning the side paneling of the coach body. Extreme care should be taken not to sand blast excessively.

REPAIR OF FIBERGLASS PARTS

NOTE: Your local supplier of fiberglass repair material can furnish the recommended materials with instructions for applying.

Repair procedures for fiberglass parts are simple and the paint refinishing procedure is generally the same as recommended for sheet metal.

In general, all repairs to fiberglass parts consist of filling the damaged area with fiberglass cloth and resin or chopped fiberglass and resin. The repair is allowed to harden and then the finishing operations are performed. Use of the various materials is determined by the type of repair to be made. Such repairs as large holes, torn sections, and separated joints require the adhesive qualities of the resin and the reinforcing qualities of the fiberglass sheets. Small dents, scratches, or pits can be repaired using resin and chopped fiberglass (roving) and filler mixed into a paste.

EXTERIOR COMPARTMENT DOORS

All exterior compartment doors are rubber hinged except engine compartment door, radiator grille door, transmission compartment door, and tool compartment door. Rubber hinged compartment doors are of the pantograph type. Doors lift out and up parallel to the side of coach and are held in open position by either a torsion bar and safety catch or rubber pull-type latch handles.

BAGGAGE COMPARTMENT DOORS (Fig. 1)

Baggage compartment doors, which are pantograph type, incorporate flush type latch locks as shown in figure 2. Lock operating latch is flush mounted at center rub rail portion of each door. Insert fingers under operating latch; then pull outward and up to unlatch door. Doors are held in open position by action of torsion bars and safety catch as shown in figure 1. In order to lower door, it is first necessary to raise door slightly, then press safety catch away from torsion bar control arm. To close door, hold door in closed position; then release and push down on latch to secure door.

This particular type latch can be adjusted to regulate door-to-body seal tightness. Make adjustment if necessary in the following manner:

1. Loosen two lock nuts (fig. 2) securing turnbuckle on release latch control link.
2. Turn link turnbuckle to obtain desired adjustment of door-to-body seal tightness, then retighten turnbuckle lock nuts.
3. Adjust upper striker (fig. 1), which has slotted holes, for seal tightness at top of door.

Baggage compartment door torsion bar tension is controlled by a lock link attached to torsion bar control arm. To adjust, turn lock link adjusting nut until satisfactory operation is obtained (see fig. 1).

CAUTION

WHEN MAKING THIS ADJUSTMENT USE EXTREME CARE NOT TO BACK ADJUSTING NUT COMPLETELY OFF LINK THREADS AS THIS WILL RELEASE TORSION BAR CONTROL ARM WHICH COULD CAUSE SERIOUS INJURY.

Removal of Door

1. Tie door fully open with a rope through door stiffener panel and two open side windows.
2. Install special tool on torsion bar control arm and hold steady while removing pin from lock link eye (fig. 2A). When pin is removed, allow arm and tool to raise until arm movement is stopped by upper edge of door opening. Remove tool from arm and perform same operation on the other torsion bar arm. NOTE: This does NOT relieve ALL tension from torsion bars.
3. Wedge a 2" x 4" (38-7/8" long with a 1/2" notch in one end) between baggage compartment floor and one torsion bar (fig. 2A). Loosen, BUT DO NOT REMOVE, all nuts which fasten torsion bar to coach. Remove nuts from studs at control arm end of torsion bar and slowly slide 2" x 4" from under bar, releasing tension. Install 2" x 4" under other torsion bar and perform same operations. Remove torsion bars one at a time. If both bars are loose, removal is easier.
4. Untie rope and lower door halfway. Support

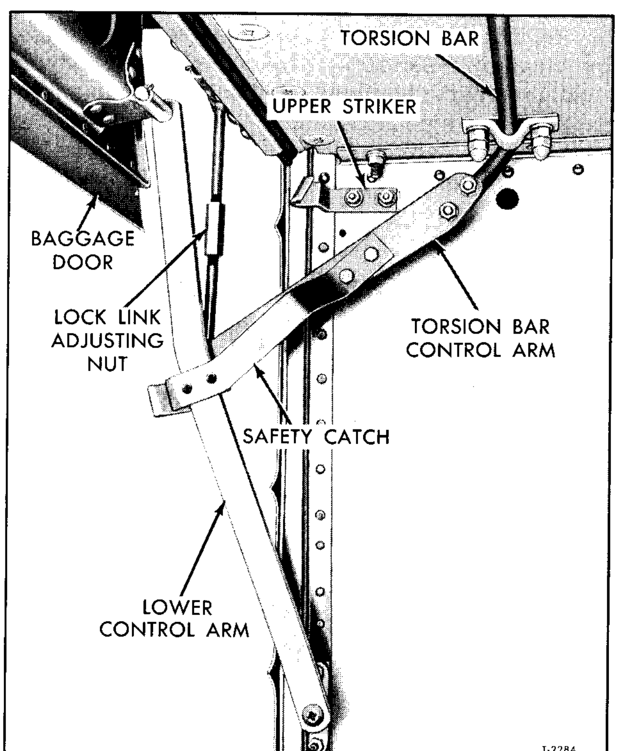


Figure 1—Baggage Compartment Door Operating Mechanism

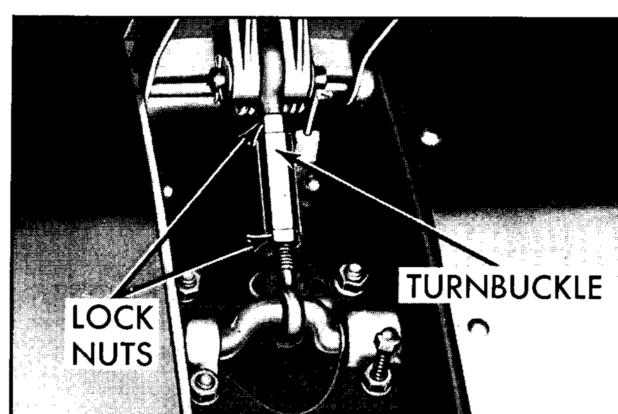


Figure 2—Compartment Door Release Latch

as shown in figure 2A. Remove screws from door half of lower hinge.

5. Remove screws from lower end of door lower control arm (fig. 1). Door is now separate from hinge panel and can be removed.

CAUTION: This door is heavy and should not be handled by one man alone.

Installation of Door

1. Set door in half-open position and align hinge panel with inside of door. Fasten hinge to door with screws (see fig. 2A).

2. Fasten lower control arms to coach body with screws (see fig. 1).

3. Tie door full open with a rope through door stiffener panel and two open side windows.

4. Place both torsion bars in position with control arm end hanging loose. Using the 2" x 4", push control arm end of one torsion bar in place and install bracket and nuts loosely. Install other torsion bar. Tighten all nuts.

5. Place special tool on one torsion bar control arm and pull arm down to align with link eye.

6. Install link pin in link eye and control arm.

7. Install flat washer and cotter pin.

8. Perform same operations (steps 5, 6, and 7) on other torsion bar control arm.

9. Check operation of door and adjust.

RUBBER HINGES

Removal and installation of rubber hinges will be made for one of two reasons: (1) because the hinge itself is defective, damaged or deteriorated, or: (2) because the door or hinge panel needs repair or replacement.

If the hinge itself needs replacement, the easiest method of removal is to simply cut the hinge down the center with a sharp knife and remove the two halves separately. Application of a soap and water solution to the old hinge, before removal, will aid the removal process.

If the reason for removal is replacement of a door or a hinge panel and the old hinge is to be reinstalled, then the hinge must be pulled out of the channels. Use of a soap and water solution (not grease or oil) will facilitate this.

The installation of the hinge is the same basic process as the removal, except that hinge is inserted in channels rather than pulled from channels. Use of a soap and water solution, glycerin, or talcum powder will facilitate installation.

IMPORTANT: Do not use oil or grease.

In most all cases, removal and installation of doors and hinges is a two man job.

In the case of removal and installation of the baggage compartment door upper hinge, the hinge must be removed or installed in both body channel and hinge panel channel at the same time. Pull hinge out of or insert hinge into notches provided in both hinge panel and body channels at the center points of the opening and of the panel. Remove or install hinge from center all the way to one end.

NOTE: When installing hinge, secure the installed half in place with one or two screws. Then, remove or install from center to other end. Holding hinge panel at right angles to side of coach and moving it laterally while removing or installing hinge, greatly facilitates the process.

To replace baggage compartment door hinges you MUST first remove door as described in procedure covering that operation.

CAUTION

DO NOT TRY TO REMOVE BAGGAGE COMPARTMENT DOOR HINGES WITHOUT RELEASING TORSION BAR TENSION - THIS IS A SAFETY PRECAUTION.

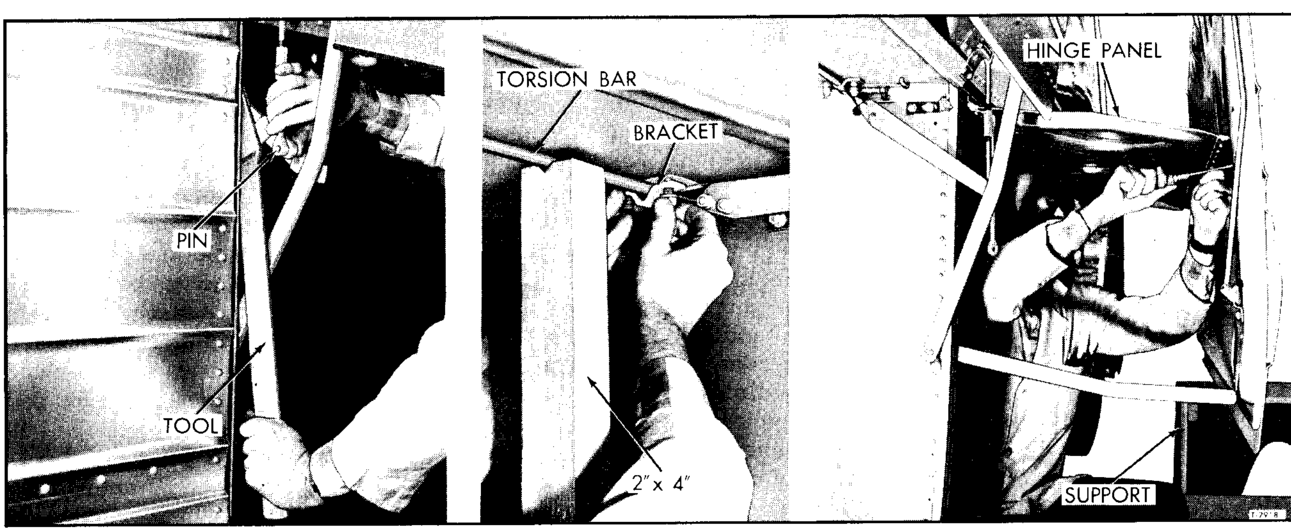


Figure 2A—Install or Remove Lock Link Pin, Control Arm End of Torsion Bar, and Lower Hinge

GENERAL BODY MAINTENANCE

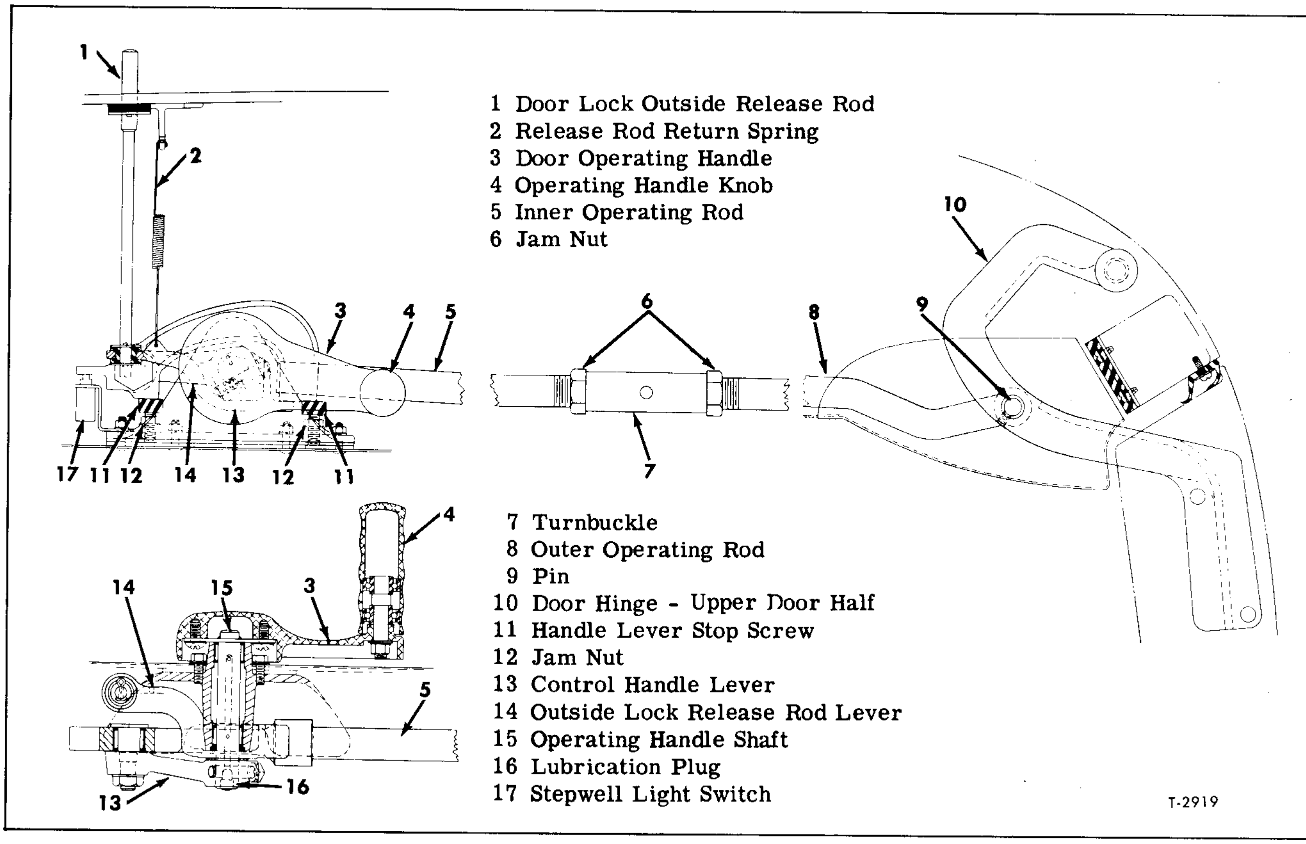


Figure 3—Entrance Door Control Linkage

ENGINE COMPARTMENT DOOR

Engine compartment door, which is hinged at top, is opened by turning lock release handle located at lower section of door. Door is retained in closed position by two locking rods which engage catches on engine rear hanger tubes. Catches can be repositioned on tubes permitting adjustment of door-to-body fit. Door is held in open position with one telescopic support prop having a hold-open retaining pin. In order to lower door it is first necessary to raise door slightly to allow removal of retaining pin from support prop.

CAUTION: Do not drop door to closed position as damage to locking rods or catches may result.

TOOL COMPARTMENT DOOR

Tool compartment door located at left front corner of coach is hinge mounted at front and swings outward. To open door, pull latch handle, which extends below left bumperette, rearward; then swing door open. Door is retained in closed position by two locking rods which engage body catches at top and bottom of door. Body catches can be repositioned to permit adjustment of door-to-body tightness by loosening catch attaching cap screws, adjusting door-to-body tightness, then retightening cap screws.

TRANSMISSION COMPARTMENT DOOR

Transmission compartment door located at right rear corner of coach is hinged mounted at front and swings outward. Door is equipped with latch at lower rear edge and is retained in closed position by locking rod which engages body catch at top and bottom of door. Body catches can be repositioned for adjustment of door-to-body tightness by loosening attaching bolts, adjusting door-to-body tightness, then retightening bolts.

A/C CONDENSER AND HEATING AND EVAPORATOR COMPARTMENT DOORS

A/C condenser and heating and evaporator doors (pantograph type) are retained in closed position with two pull-type latch handles located under doors, and 2 turn-screw locks at top of doors.

To open doors, pull latch handles out and down and rotate turn-screws 1/4 turn to disengage latch. Doors lift out and up parallel with side. Doors are held open by a pull-type latch on body at upper end of compartment. To close door, pull latch out and down to release.

Hold door in closed position and rotate turn-screws until latch is engaged, then pull latch handles at bottom of door up and release in door catches.

CAUTION: Do not drop doors to closed position as damage to doors or body may result.

RADIATOR GRILLE AND A/C COMPRESSOR COMPARTMENT DOOR

Radiator grille and A/C compressor compartment door is hinged at top and held closed with two pull-type latch handles located under door. To open, pull latch handles outward and release. Door is held open by support rod.

SPARE TIRE COMPARTMENT DOOR

Spare tire compartment door at front center of coach in back of front bumper also serves as a mounting for the front bumper. Door is hinged at bottom and attached to body framing at top of door with two special lug bolts. To open door, insert wheel lug wrench through each hole in bumper bar and remove lug bolts; then lower bumper and door.

To close door, raise bumper and door assembly to closed position. Insert two attaching lug bolts and tighten firmly.

ENTRANCE DOOR AND CONTROLS

Entrance door is sedan type, hinged at front, and opens outward. Door is hand-operated controlled by operating mechanism connected between dash and door. Mechanism is so designed that door is locked firmly when fully open or fully closed. Door can be opened from outside vehicle by pushing in on door release rod knob (1, fig. 3) located in front panel below windshield.

Adjustment

NOTE: Key numbers in text refer to figure 3.

Mechanism is adjusted by loosening two jam nuts (6), which lock turnbuckle (7) connecting door operating rods (5 and 8); then turning turnbuckle to shorten or lengthen rods. Turnbuckle is accessible under dash after entering safety compartment at right side of dash. Tighten turnbuckle jam nuts (6) after desired adjustment of rods is obtained.

Two stop screws (11), which are adjustable, are located on each side of control handle lever (13) under dash panel. Adjustment of stop screws regulate the over-center position of door operating rod control handle lever (13). Properly adjusted mechanism will swing over-center and lock door firmly in both fully open or closed position. In either position, it should not be possible to move door unless operating handle (3) is first moved out of locking position. After adjusting stop screws (11), tighten stop screw jam nuts (12).

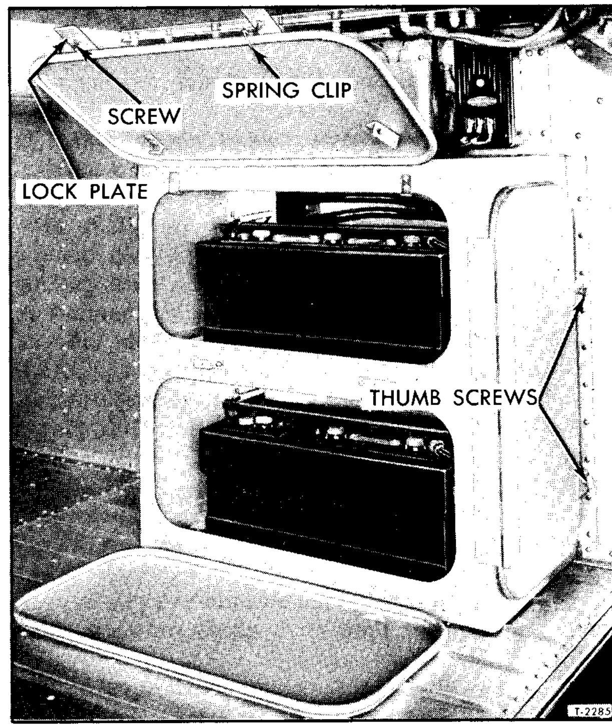


Figure 4—Battery Compartment Doors

SERVICE ACCESS DOORS

These doors are: fuel tank filler door, located forward of the heating and evaporator door; lavatory filling and flushing door (if used), located forward of the transmission compartment door; oil filler access door located in the engine compartment door; and surge tank filler access door, located above radiator compartment door. They are piano-hinged, spring loaded, and remain opened or fully closed except lavatory filling door, which opens only to a 45° angle.

BATTERY COMPARTMENT DOORS (Fig. 4)

The battery compartment, located in left rear baggage compartment, has three access doors. The side door is hinge mounted at right and swings out after loosening thumbscrews securing door to battery box frame. Upper front door is hinge mounted at top and lower door is hinge mounted at bottom. Loosen screws in lock plate to open doors. Upper door is retained in open position by securing spring clip on coach floor to door.

INTERIOR COMPARTMENT DOORS

FRONT COMPARTMENT DOOR

Front compartment door, located above stepwell, is hinge mounted at bottom. To open, lift handle at top of door and rotate one quarter turn. Door is held in open position by chain attached to door and compartment panel.

LAVATORY COMPARTMENT DOOR

Lavatory compartment (if coach is so equipped) door is rubber hinge mounted and opens out. Lock is covered later in this section under "LAVATORY."

SASH AND GLASS

RUBBER INSERT-RETAINED GLASS

A special insert-type rubber retainer seal is used to install all glass except long side windows. Windshield, rear window, astrolight, driver's window, entrance door, and No. 1 window glass sections are retained in body openings with bonded seal retainer assemblies which eliminate cutting of retainer to install glass. Although possible to install retainer and seal insert without use of special tool, seal and insert installer tool (J-2189) (fig. 5) is recommended to facilitate installation.

CAUTION: Wear gloves when handling glass.

GLASS REMOVAL

1. Raise one end of insert out of groove in retainer seal with pointed tool; then pull insert from seal by hand.
2. Station an assistant outside vehicle to prevent glass falling; then push glass outward from inside coach.
3. Remove rubber retainer seal or seal assembly from panel by hand.

GLASS INSTALLATION

1. Straighten panel flange around opening to assure a good fit in retainer seal groove.
2. Position retainer seal in panel cut-out, making sure seal is pushed into place in corners. When installing glass in destination sign, make sure ends of seal come together at side of opening near top. Cut off retainer seal ends allowing sufficient overlap to secure a tight joint, then carefully butt seal into position.
3. Apply parafin to glass groove in retainer seal to facilitate glass installation.
4. Position glass to seal, then insert end of retainer seal installer tool (J-2189) in seal groove. Move tool along edge of glass forcing outer lip of seal over glass.
5. Thread end of rubber insert through handle and eye of seal installer tool (fig. 5). At point opposite joint in retainer seal, push tool eye and end of insert into seal groove. Feed into groove in retainer seal using a "hitching" motion to prevent elongation of insert.
6. Cut off insert, allowing sufficient overlap, and butt ends tightly into groove.

REAR WINDOW SHIMS

If rear window becomes loose, rubberized felt shims are available to correct the condition.

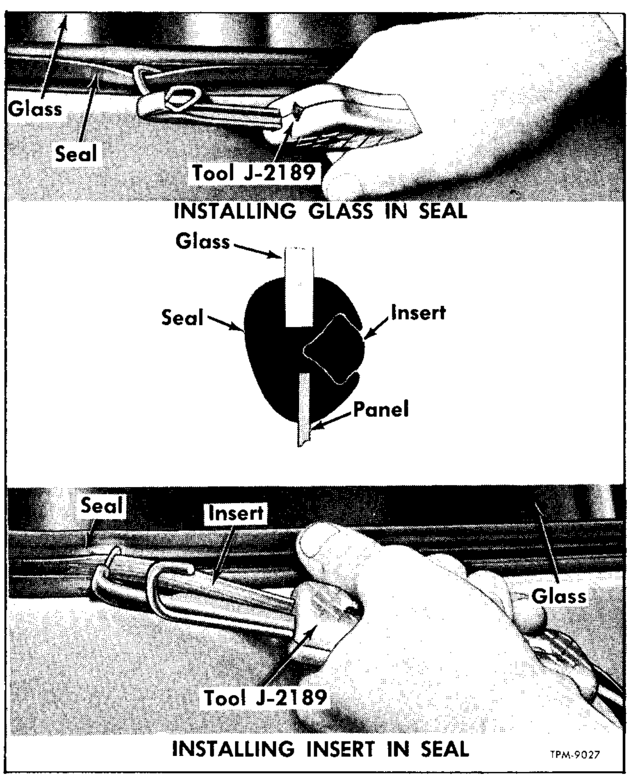


Figure 5—Replacing Insert-Retained Glass

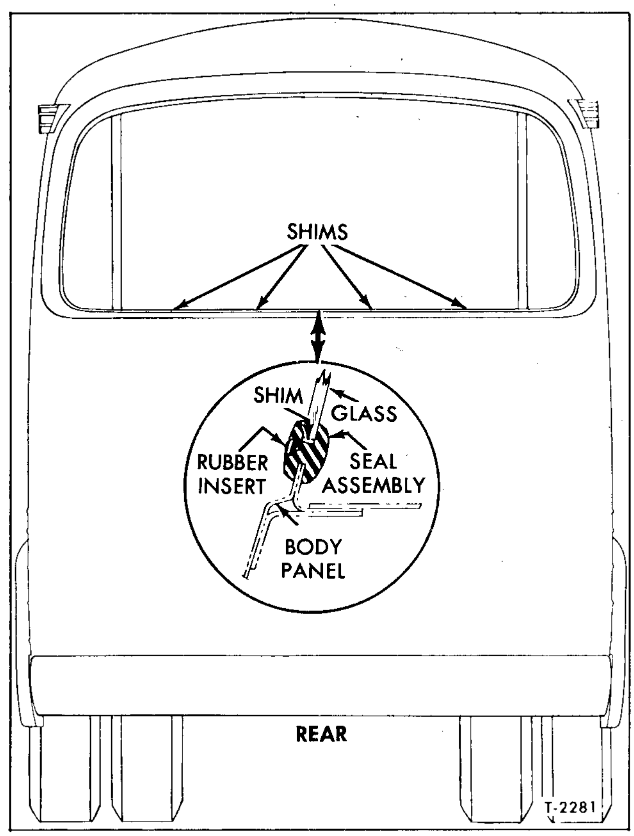


Figure 6—Installation of Rear Window Shims

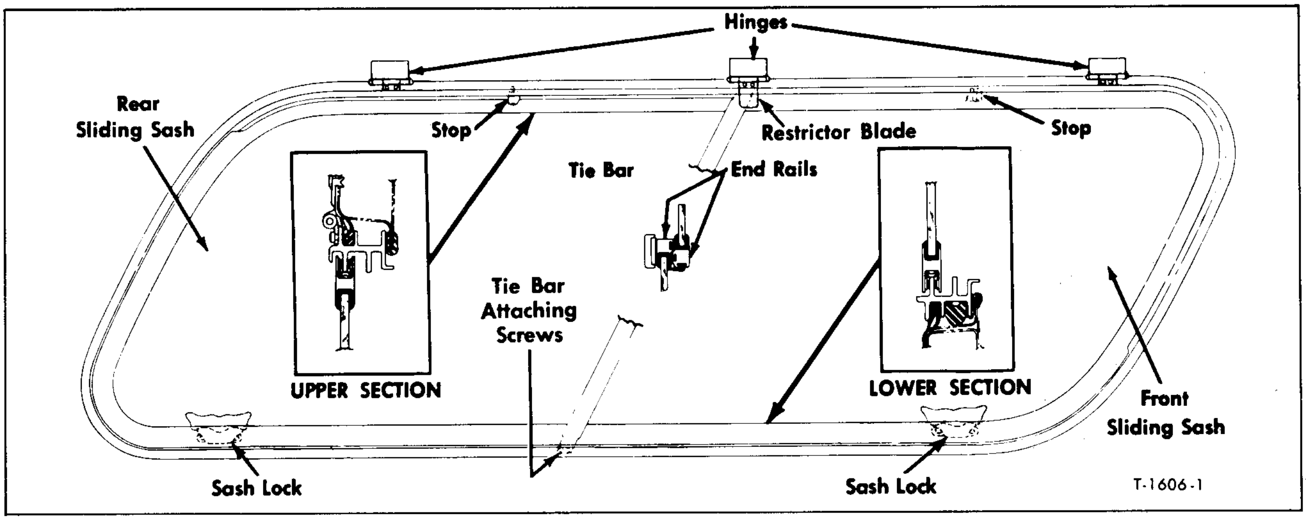


Figure 7—Long Side Window Sash Assembly

With glass removed, inspect the window opening to determine if new parts are needed. If parts are corroded or rusty, refinish them in accordance with procedures outlined earlier in this section.

After installation of new parts or refinishing old parts, install the rear window glass using rubberized felt shims (also called "equalizers") as needed to obtain correct fit. The shims should be 4 inches long and installed as shown in figure 6. Refer to Parts Catalogue for part number of shims and order from the serving GMC Parts Warehouse.

LONG SIDE WINDOW SASH

Long side windows consist of two sections of sliding sash and glass enclosed in a one-piece aluminum frame (fig. 7). Window can be opened by sliding front section rearward and rear section forward. Each section is retained in closed position by a latch-type lock.

EMERGENCY ESCAPE

Long side windows are hinged at top to provide passenger escape under emergency conditions. Window is retained in closed position at bottom by two studs and stud receptacles (fig. 8). Studs are attached to body panel by retaining clips and receptacles are retained in sash channel grooves by means of nibs on receptacles. Pushing outward on lower portion of window will cause opening in receptacle to expand and release studs, thus permitting window to swing outward.

SIDE WINDOW REMOVAL

Side window is readily removed after first opening window to emergency release position. With the aid of an assistant to hold window, remove screw from end of each hinge pin, then remove pins from hinges. Push out at top of sash, then lower window assembly from opening.

SIDE WINDOW INSTALLATION

1. Before installing window, inspect window outer seal and rubber support blocks. Replace if necessary. Also, check condition of push out studs

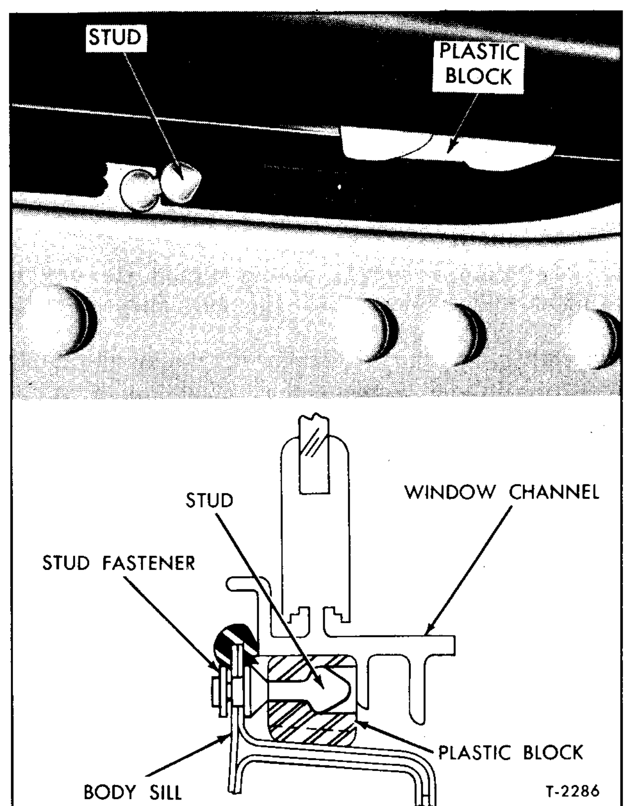


Figure 8—Long Side Sash Push-Out Stud and Receptacle Installed

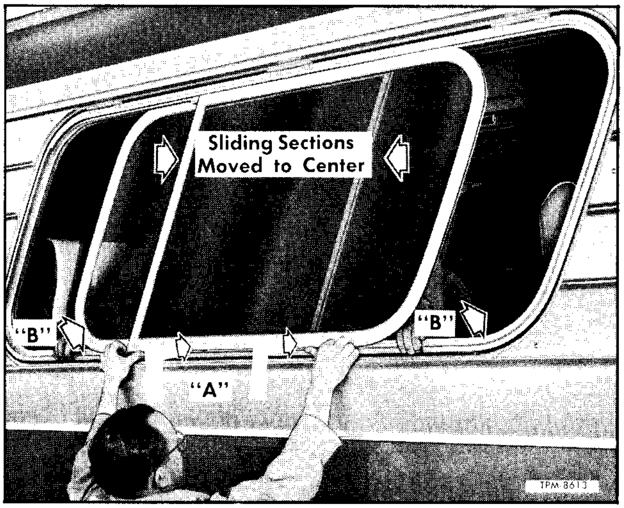


Figure 9—Installing Long Side Window

and receptacles at bottom of sash. Figure 8 shows studs and receptacles installed. If necessary, either can be readily replaced.

2. With support blocks located at bottom and ends of window frame, position window assembly to opening in coach. Insert hinge pins, then secure each with a screw.

3. Referring to figure 9, slide front and rear sections to center, raise bottom of sash at point "A," and then let weight of window assembly rest on body sill. Inside of coach, at points "B," pull inward evenly to installed position.

SLIDING SASH AND GLASS REMOVAL

CAUTION: Wear gloves when handling glass.

1. Remove side window as previously directed under "Side Window Removal."

2. Remove screws which attach tie bar to window frame (View "A," fig. 10). Purpose of tie bar is to prevent window frame from spreading in the center when window is being carried or when in emergency escape position.

3. Referring to View B, fig. 10, spread window frame in the center only enough to permit removing sash and glass sections from frame channels.

4. To disassemble sash and glass sections, remove screw (View A, fig. 11) at upper and lower end of section vertical-slanting end rail. Remove end rail, then carefully remove broken glass and glazing rubber from sash.

SLIDING SASH AND GLASS INSTALLATION

1. Clean glass sash channels thoroughly.

2. Position new glazing rubber on glass; then using parafin or glycerine on glazing rubber to facilitate glass installation, install glass with rubber in sash.

3. Using a strong cord as a tourniquet to press sides of frame into position as shown in View B, figure 11, install vertical-slanting end rail to sash with attaching screws.

4. Spread window frame apart at center only sufficiently to allow installing sash in frame channels (View B, fig. 10).

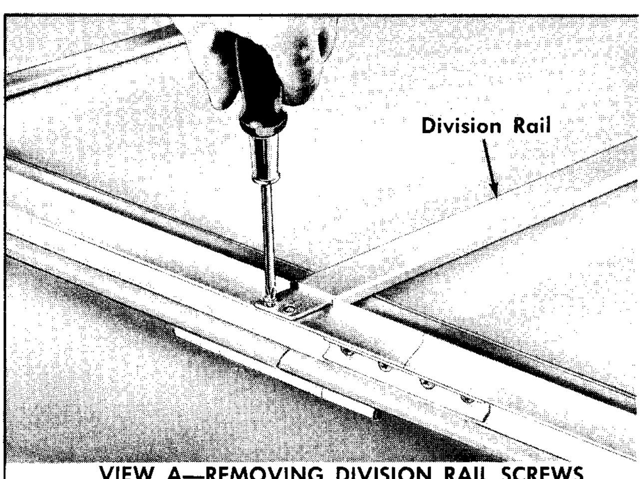
5. Install tie bar to window frame with screws (View A, fig. 10).

SLIDING SASH POSITION LOCK (Fig. 12)

Two lock assemblies are located at bottom of window assembly for retaining sliding sections in closed or open positions.

Pushing downward on either end of rocker will free pawl from notch in sash rail. If release mechanism binds or fails to operate properly, remove lock assembly from sash frame.

Remove backing plate and inspect operation of internal parts. If necessary to disassemble, pull two lever pins, invert lock and allow levers



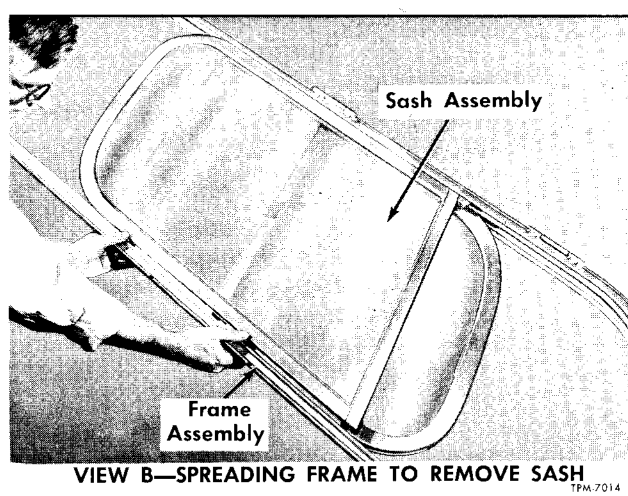


Figure 10—Replacing Long Sash Sliding Sections (Typical)

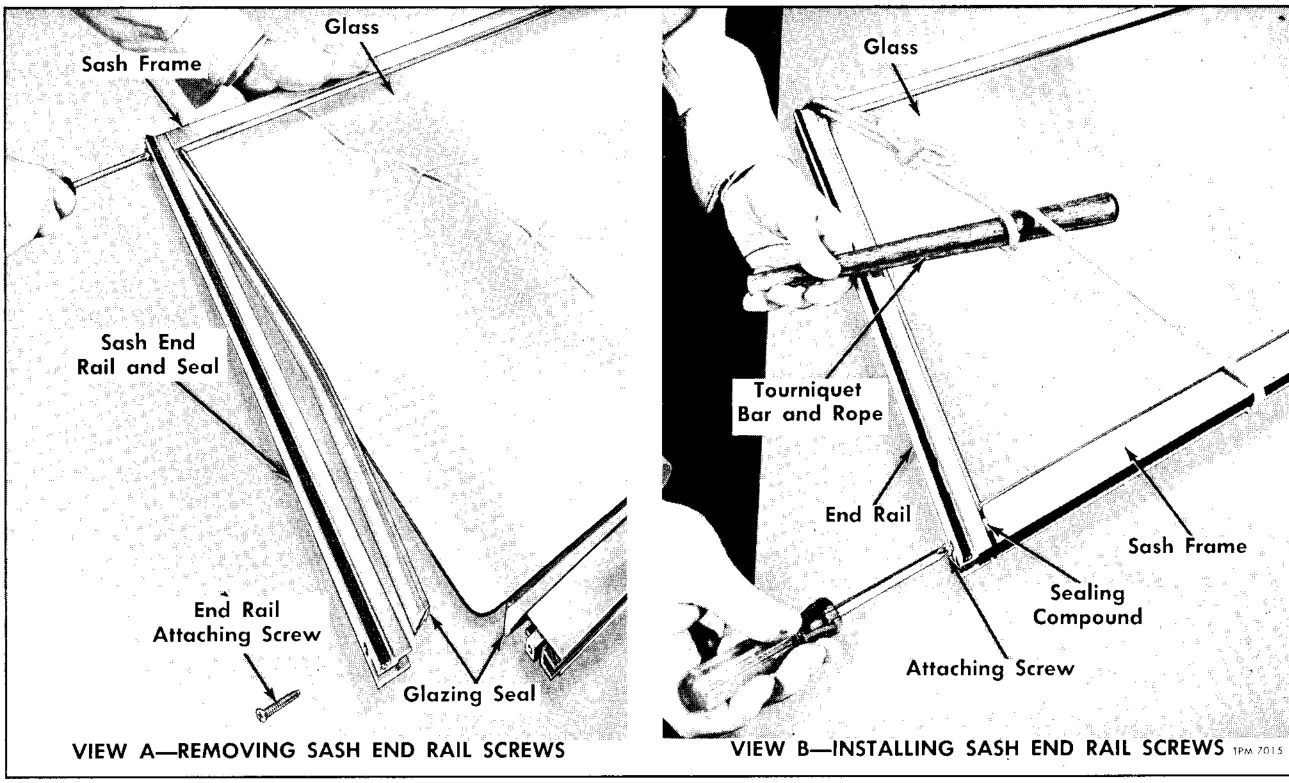


Figure 11—Replacing Sliding Section Glass (Typical)

to drop out. Pull rocker pin, lift rocker off housing and remove pawl and springs. Check for broken, distorted or weak springs and also for rough spots or "flashing" on all sliding surfaces. Use new parts where necessary.

Install pawl and springs, making sure that springs slide over guide posts in housing. Set rocker in position and install rocker pin. Place two levers in position and fasten with lever pins. Place backing plate in position and fasten lock assembly to sash with two screws (fig. 13).

NOTE: DO NOT LUBRICATE LOCK. These locks are made of a special plastic and do not require lubrication. Lubrication tends to attract and hold dirt, causing malfunction.

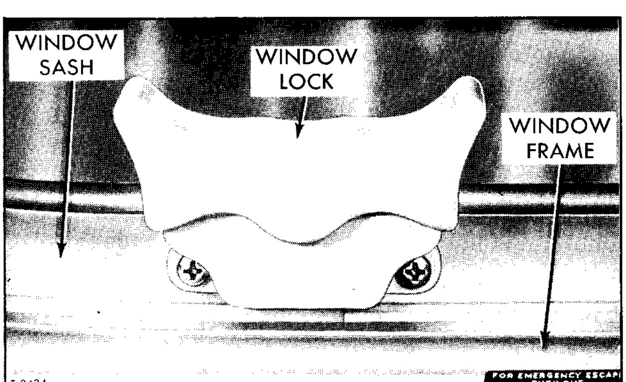


Figure 12—Long Sash Lock Mechanism

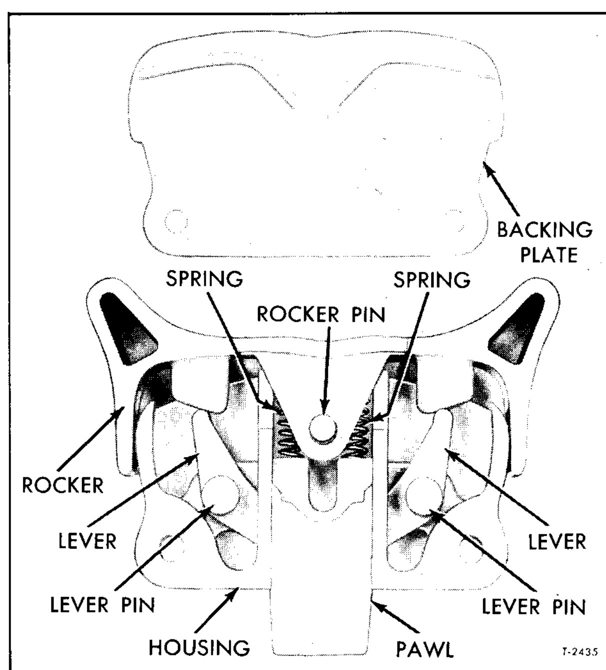


Figure 13—Long Sash Lock Mechanism Installed

GENERAL BODY MAINTENANCE

DRIVER'S SIGNAL WINDOW

Driver's signal window, located at lower rear corner of driver's window, consists of two sections enclosed in a one-piece aluminum frame. Forward section slides while rear section is stationary.

SLIDING GLASS SECTION

Removal

1. Remove four screws attaching lower rail to lower channel.
2. Remove sliding section from frame; then remove three screws attaching seal to end rail.
3. Remove two screws from end rail, remove rail and pull glass from sash.

Installation

1. Position new glazing rubber on glass; then using parafin or glycerine on glazing rubber to facilitate glass installation, install glass with rubber in sash.
2. Replace end rail and attach with two screws.
3. Attach seal to end rail with three screws, and insert sash in frame.
4. Replace lower rail and attach with four screws.

STATIONARY GLASS SECTION

Removal

1. Remove sliding sections from frame as previously directed.
2. Pry four rubber retainers from stationary window channel and remove glass.

Installation

1. Install new glass and insert four rubber retainers. If necessary, parafin or soap solution can be applied to rubber to facilitate installation.
2. Replace sliding section and secure as previously directed.

MISCELLANEOUS EQUIPMENT

WINDSHIELD WIPERS

Two electrical, dual-speed type windshield wiper motors are mounted under dash on right and left front panels. Windshield wiper motors are individually controlled by switches on instrument panel. Windshield wiper arm and blade assemblies (fig. 14) are pantograph type which keeps wiper blade parallel with windshield edge throughout cross sweep. Wiper motor units incorporate parking switch contacts which keep electrical circuit closed, permitting blades to return to "Park" position (approximately 5.5 inches from center post of windshield) after dash switch is turned off. "Windshield Wiper Wiring Diagram" is located in back of this manual.

WIPER ARM AND BLADE ANGLE ADJUSTMENT

WIPER ARM ADJUSTMENT

To adjust sweep of blades to provide maximum visibility, turn on wipers, then note sweep of arms. If necessary, remove one or both arms as follows:

Loosen wiper arm head clamp bolt. Remove crown nuts and flat washers which attach wiper arm and idler arm to knurled driver and idler arm shaft (fig. 14). Relocate wiper arm on knurled driver to obtain desired position. Install crown nuts and flat washers securing wiper arm and idler arm. Tighten arm head clamp bolt.

BLADE ANGLE ADJUSTMENT

Idler arm length is adjustable to allow setting wiper blade angle. Each blade should travel across windshield in a position so that when the arm is at the end of its inward sweep, the wiper blade should be parallel with edge of windshield as shown in figure 14. If necessary, adjust angle of blade as follows:

1. Loosen lock nut on idler arm.
2. Remove crown nut which attaches arm to pivot shaft. Remove arm from shaft, then while holding outer end of idler arm turn arm to shorten or lengthen overall length of assembly to obtain proper adjustment.
3. Reinstall arm on pivot shaft, turn on wipers and check angle of blade.
4. Repeat adjustment if necessary, then install crown nut on pivot shaft. Secure nut firmly. Tighten lock nut on idler arm shaft.

IMPORTANT

DO NOT ATTEMPT TO MANUALLY MOVE WIPER ARMS AS DAMAGE TO LINKAGE OR MOTOR MAY OCCUR.

WIPER ARM REPLACEMENT AND REPAIR

Arm Removal (Fig. 14)

1. Remove crown nut at wiper arm and the idler arm crown nut.
2. Mark relationship of arm head to end of knurled driver to assure original position if arm is to be reinstalled.
3. Using a hex-wrench, loosen bolt which clamps arm head to shaft. Remove wiper arm and idler arm.

Repair (Fig. 15)

NOTE: Instructions for repairing arm assembly pivot components are included in arm pin and bushing service repair kit. However, the procedure for releasing and installing tension spring is as follows:

1. Remove small cotter pin which retains anchor pin at upper end of tension spring.
2. Drive out anchor pin to release the spring and the spring eye bushing. Spring can then be removed from link lever assembly.
3. Before installing spring, install anchor pin with bushing to arm. Install anchor pin cotter pin.
4. Using a strong hooked instrument, stretch spring to engage anchor pin.

Arm Installation (Fig. 14)

NOTE: Apply small amount of high temperature zinc oxide lubricant to idler arm pivot shaft.

1. Make sure wiper motor is in "Park" position, then locate wiper arm on knurled driver and idler arm on pivot shaft. If original wiper arm is being installed, align marks made prior to removal.
2. Operate wiper on wetted glass and check blade sweep and angle. If necessary, reposition wiper arm and make blade angle adjustment as explained previously.
3. Tighten arm head clamp bolt and install flat washers and crown nuts securing wiper arm and idler arm.

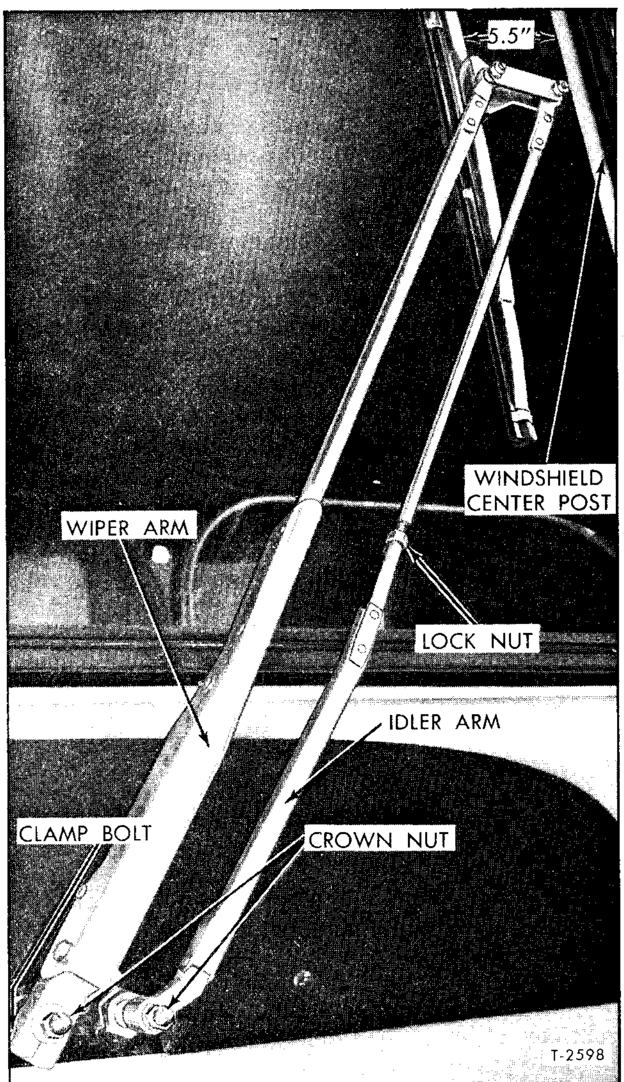


Figure 14—Windshield Wiper Arm and Blade

WIPER MOTOR REPLACEMENT AND OVERHAUL

REPLACEMENT

Removal

1. Remove wiper arm linkage at front of windshield. Remove nuts and spacer from motor linkage shafts.
2. Remove wiring harness from electrical terminals on wiper motor and relay.
3. Remove two screws, nuts and washers securing motor bracket to front body panel. Remove motor unit from under dash panel.

Installation

NOTE: Apply body sealer compound at shaft outlets and mounting screw holes prior to mounting wiper motor assembly.

1. Place wiper motor with assembled linkage into position and attach to body panel with two screws and washers. Also at front of vehicle install spacer and nuts which retain motor shafts in position. Tighten wiper arm shaft spanner nut to 18 to 20 foot-pounds torque and idler arm shaft retaining nut to 25 to 30 foot-pounds torque.
2. Connect wiring harness to motor and relay terminals. Operate motor and observe cycling of wiper arm shaft. Turn motor off; wiper shaft should return to "Park" position (blades park near center of windshield).

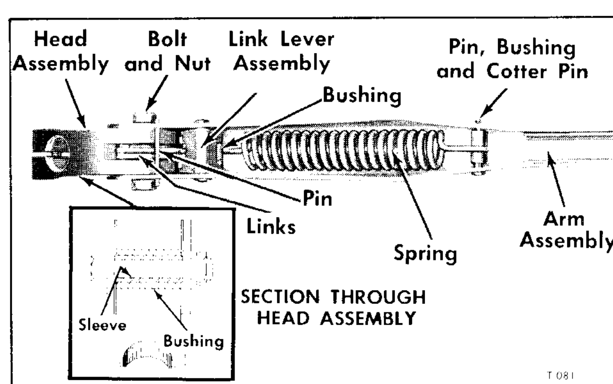


Figure 15—Wiper Arm Assembly

3. Apply small amount of high temperature zinc oxide lubricant to motor and pivot shafts. Position wiper arm over serrations of knurled motor drive shaft and idler arm on pivot shaft. Tighten arm head clamp bolt and install crown nuts and washers securing wiper arm and idler arm.

TROUBLESHOOTING

NOTE: Refer to "Windshield Wiper Wiring Diagram" in back of manual and figure 16 when troubleshooting electrical circuit.

TYPICAL TROUBLE CONDITIONS

1. Wiper will not shut off.
2. Wiper inoperative.
3. Wiper has one speed (High).
4. Wiper has one speed (Low) and shuts off with dash switch in "High" position.
5. Blades do not return to "Park" position when wiper is turned "Off."
6. Wiper speed normal in "Low" speed position but too fast in "High" speed position.
7. Wiper operates intermittently.

CHECKING INSTALLED WIPER

Wiper Will Not Shut Off

1. Determine if wiper operates in both "High" and "Low" speeds, "Low" speed only, or "High" speed only.

IMPORTANT: Wiper must operate in "Low" speed during parking cycle.

2. Disconnect wiring harness from wiper motor and relay. Operating wiper independently of the dash switch as shown in figure 16. If wiper operates correctly independently of the dash switch and relay (shuts off correctly with crank arm in "Park" position) refer to possible causes below:

a. If wiper operates at high speed when dash switch is placed in "Off" position, lead between wiper terminal No. 1 and relay terminal No. 1 may be grounded. Lead between relay terminal No. 5 and dash switch may be grounded or relay or dash switch are defective.

b. If wiper operates at low speed when dash switch is placed in "Off" position, lead between motor terminal No. 3 and relay terminal No. 2 may be grounded. Lead between relay terminal No. 5 and dash switch may be grounded, or relay and/or dash switch are defective.

3. If wiper still fails to operate correctly, remove unit, then remove covering from over drive gears and check parking switch contacts which may be broken or stuck in closed position. Check for a grounded lead at No. 1 or No. 3 terminal (fig. 16), or for a grounded shunt field.

Wiper Inoperative

1. Check wiring harness connections at motor, relay and at dash switch.
2. Check No. 4 circuit breaker located in driver's control panel.
3. Check for loose ground wire at dash switch.
4. If wiper still fails to operate, disconnect wiring from motor, and check for 12 volts at relay terminal No. 4 and motor No. 2 terminal. No voltage indicates defective wiring.
5. With harness connected to wiper motor, check relay operation. Refer to Section 7 for electrical test procedures of wiper relay.
6. With harness disconnected from motor, try operating motor as shown in figure 16. If wiper fails to operate, remove unit from vehicle for disassembly.

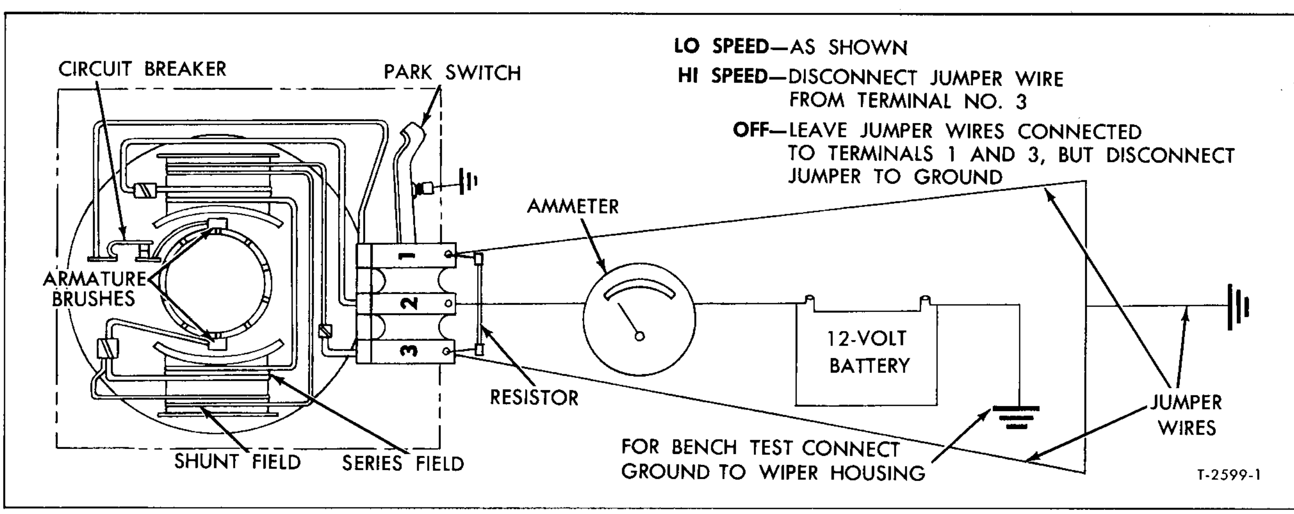


Figure 16—Wiper Motor Test Schematic

Wiper Has One Speed - Fast

1. Check for open lead between motor terminal No. 3 and relay terminal No. 2, or open lead between relay terminal No. 1 and dash switch.

2. Check for defective dash switch or relay. Refer to Section 7 for test procedures on relay.

Wiper Has One Speed (Low) and Shuts Off With Dash Switch in "High" Speed Position

Reverse harness leads that connect to motor terminals No. 1 and No. 3.

Blades Do Not Return to "Park" Position When Wiper is Turned Off

1. Check wiper motor ground connection to coach.

2. Remove wiper motor and check for dirty, bent or broken "Park" switch contacts.

Wiper Speed Normal in "Low" But Too Fast in "High"

Remove wiper motor from coach and check for an open terminal board resistor.

Intermittent Operation

Check for loose wiper relay connections and/or loose dash switch connections.

CHECKING WIPER MOTOR AT BENCH

Wiper Inoperative - Make Current Draw Check

Connect 12 volt supply and ammeter (30 amp) to wiper motor as shown in figure 16 (for "Low" speed operation) and observe current draw and wiper operation.

If Current Draw is "Zero.":

1. Check solder connection at wiper motor No. 2 terminal.
2. Check for loose connection at splice joints.
3. Check for defective circuit breaker.

If Current Draw is 2 Amperes:

1. Disassemble motor and check the following:
a. Open armature.
b. Brushes sticking.
c. Loose splice joints at brushes.

If Current Draw is 6 - 8 Amperes: (Wiper Runs Slow and is Noisy)

1. Check for shorted armature.
2. Check armature and gearshaft end play.

If Current Draw is 20 Amperes:

1. Check for broken drive gear.
2. Check for loose motor frame thru-bolts, damaged brushes or excessive bearing wear which causes locked armature.

Wiper Has "High" Speed Only

See reasons explained later under "Wiper Will Not Shut Off."

Wiper Has "Low" Speed Only

See reasons explained later under "Wiper Will Not Shut Off."

Wiper Will Not Shut Off

1. Check to see if "Park" switch contacts open.
2. Wiper motor leads at No. 1 or No. 3 terminals are grounded.
3. Check for open shunt field.

Wiper Crank Arm Does Not Return to "Park Position

Check for dirty, bent or broken "Park" switch contacts.

Wiper Speed Normal in "Low" But Too Fast in "High" (Crank Arm Exceeds 80 RPM)

Check for open resistor on back of wiper terminal board.

Intermittent Operation

Check for sticking brushes, or loose splice joints.

WINDSHIELD WIPER MOTOR AND BRACKET DISASSEMBLY AND ASSEMBLY

(Key Numbers in Text Refer to Figure 17)

DISASSEMBLY

1. Remove retaining rings (3) securing connecting link (4) to transmission shaft (5) and crank arm (11). Remove connecting link.

2. Remove bolts (9) and spacers (10) which secure motor assembly (6) to mounting bracket (2).

3. Remove nut (13) and lock washer (12) which secure crank arm (11) to motor assembly. Separate arm from motor shaft.

NOTE: Match mark motor shaft and crank arm for proper positioning of arm during reassembly.

4. Remove retaining ring (1) from transmission shaft (5). Drive shaft out of bearing housing on mounting bracket (2).

ASSEMBLY

1. Insert transmission shaft (5) in mounting bracket bearing housing (2).

NOTE: Lubricate transmission shaft using grease specified in LUBRICATION (SEC. 13) of this manual.

2. Install retaining ring (1) securing transmission shaft (5) in mounting bracket (2).

3. Position motor crank arm (11) on motor assembly (6). Install lock washer (12) and retaining nut (13) finger-tight. Clamp crank arm in vise and tighten retaining nut securely.

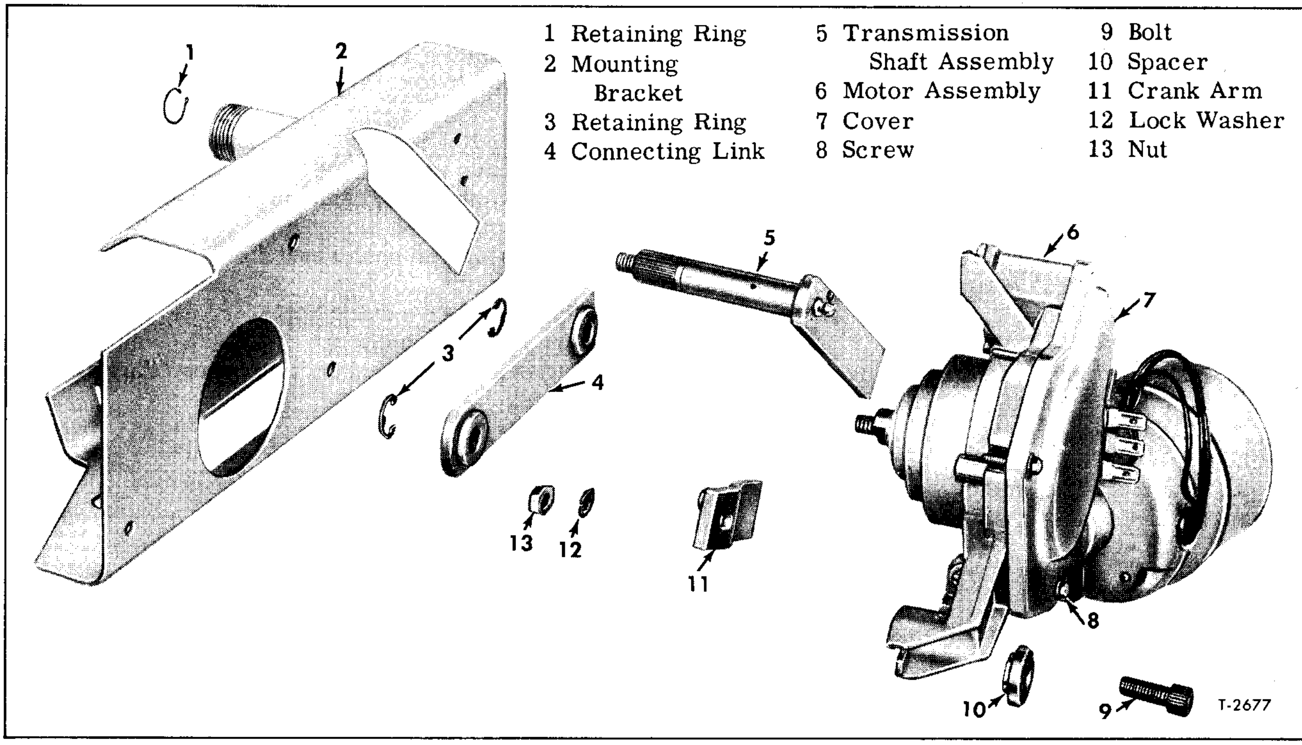


Figure 17—Wiper Motor and Bracket—Partially Disassembled

NOTE: Align match marks on crank arm and motor shaft, which were made during disassembly, to ensure proper wiper operation.

4. Install motor assembly (6) on mounting bracket (2) using spacers (10) and bolts (9).

5. Position connecting link (4) on crank arm (11) and transmission shaft (5) and secure with retainer rings (3).

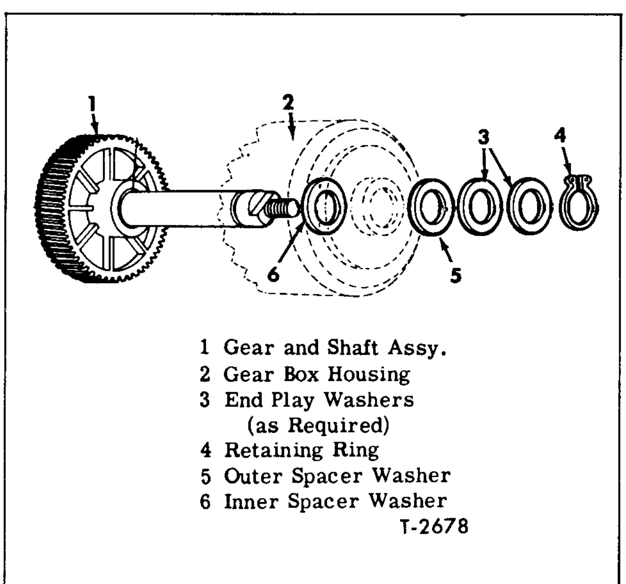


Figure 18—Wiper Motor Gear Box Components

WIPER MOTOR DISASSEMBLY AND ASSEMBLY

NOTE: The motor section and gear box assembly may be disassembled independently.

GEAR BOX DISASSEMBLY

NOTE: Key numbers in text refer to figure 18 unless otherwise indicated.

1. Remove screws (8, fig. 17) securing gear box cover (7, fig. 17) and remove cover from motor assembly.

2. Remove retaining ring (4) from gear shaft (1). Remove end play washers (4) and outer spacer washer (5).

NOTE: Retain end play washers as a pack for reassembly.

3. Remove screw securing "Park" switch (fig. 22). Remove switch, spacer, and terminal board.

4. Slide gear and shaft assembly (1) out of housing (2) and remove inner spacer (6).

MOTOR DISASSEMBLY

1. Scribe a reference line along side of casting and end cap to insure proper assembly (fig. 19).

2. Remove two motor thru-bolts (fig. 19) securing end cap to housing.

3. Feed exposed excess length of motor leads through the housing grommet and carefully back end cap with field assembly and armature away from casting (fig. 19).

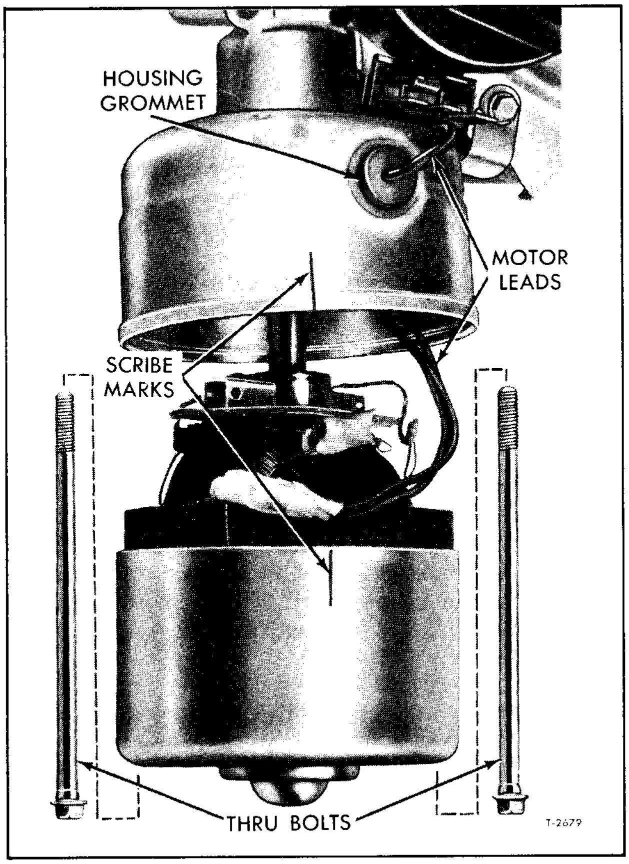


Figure 19—Separation of Wiper Motor End Cap from Housing

NOTE: It may be necessary to remove armature end play screw (fig. 22) and insert a rod through opening to apply pressure against end of armature.

4. Unsolder black cotton-covered lead from circuit breaker (fig. 20).
5. Straighten four tabs securing brush plate to field coil. Holding brushes away from armature commutator, carefully lift brush holder far enough to clear armature commutator.
6. Allow brush attached to field lead to move out of holder, remove brush spring and lift brush holder off armature shaft.
7. Lift armature shaft out of field assembly and end cap. Remove armature shaft thrust ball.

NOTE: Thrust ball may be easily removed using a magnet.

8. Remove steel thrust plate, rubber disc, and felt washer from end cap bearing.
9. The end cap and field assembly is serviced as a unit. If damaged, free field and cap assembly from housing by cutting black plastic covered lead and black with pink stripe lead at convenient splicing location near terminal board.

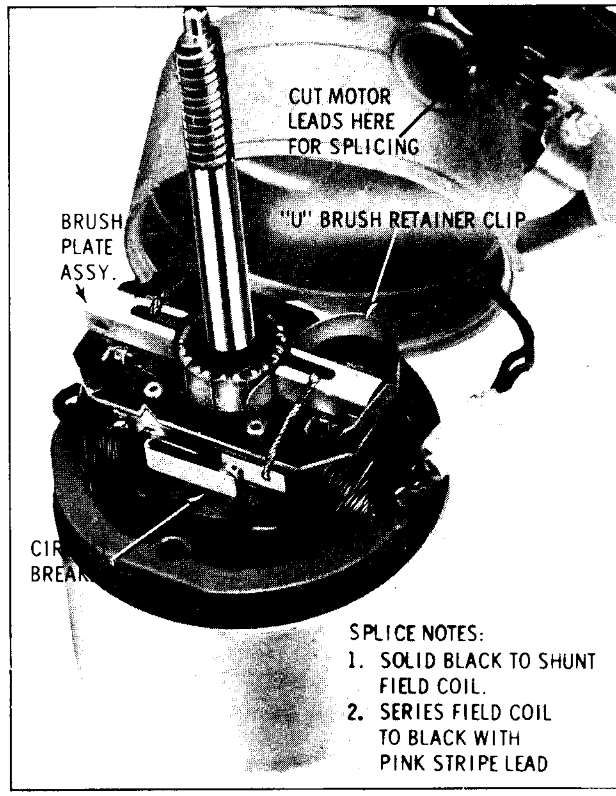


Figure 20—Armature, Field, and End Cap Assembly

MOTOR REASSEMBLY

1. If new field and end cap assembly is being installed, splice black and black with pink stripe leads of new field coil to corresponding wiper terminal board leads.
2. Install rubber thrust disc, steel thrust disc and felt lubricating washer in end cap bearing in order indicated.

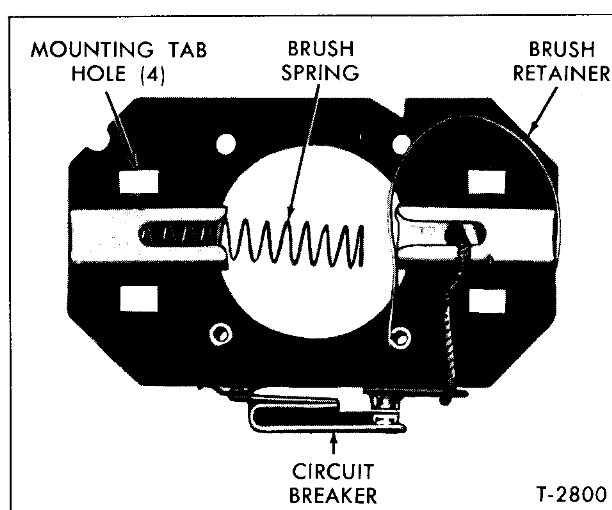


Figure 21—Brush Holder Plate

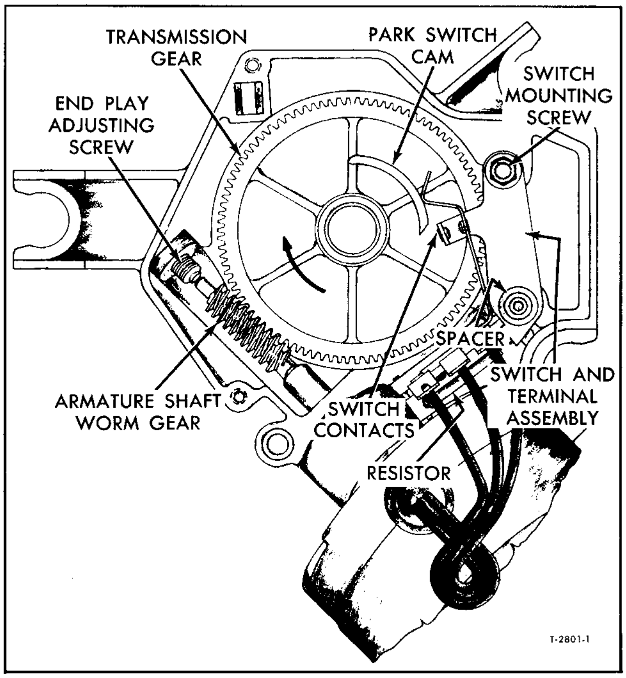


Figure 22—Wiper Motor Gear Box Assembled

3. Lubricate end of armature shaft that fits in end cap bearing with Texaco Multifax EP-1 or equivalent. Position thrust ball in end of armature shaft.

4. Insert armature in field and end cap assembly.

5. Position partially assembled brush holder (fig. 21) over armature shaft far enough to allow reassembly of brush, attached to field lead, and spring in holder.

NOTE: Brush retainer may be used (fig. 21) to retain brush and spring in position in holder while installing assembly over armature commutator.

6. Hold brushes away from armature commutator and slip brush holder over commutator and seat on mounting tabs (fig. 20).

NOTE: Black lead will not reach circuit breaker terminal if brush holder is positioned wrong.

7. Center brush holder holes and bend tabs to secure in position. Remove brush retainer clips if used.

8. Resolder black cotton covered lead to circuit breaker terminal.

9. Position armature worm shaft inside housing and, using scribed marks made during disassembly, align end cap and field assembly with housing (fig. 19).

10. Maintain armature shaft in position and slide shaft through housing bearing. At same time carefully pull excess black and black with pink stripe leads through housing grommet.

11. Rotate end cap as required to align bolt holes and secure with thru-bolts (fig. 19). Refer to "Adjustments" in this section for end-play.

GEAR BOX ASSEMBLY

NOTE: Key numbers in text refer to figure 18 unless otherwise indicated.

1. Install inner spacer washer (6) on gear and shaft assembly (1).

2. Apply lubricant, Texaco Multifax No. 2 or Sun Oil Co. Prestige No. 42 or equivalent, to gear and shaft assembly and worm shaft (fig. 20).

3. Slide gear and shaft assembly into gear box housing (2), install outer spacer (5), end play washers (3) and retaining ring (4). Refer to "Adjustments" in this section for end-play.

4. Carefully install switch and terminal board (fig. 22). Secure switch using mounting screw.

CAUTION: When installing terminal board, be careful that resistor leads do not ground on housing.

5. Position spacer (fig. 22) on switch and install cover (7, fig. 17) and secure with screws (8, fig. 17).

WIPER MOTOR INSPECTION AND REPAIR

TRANSMISSION LINKAGE

NOTE: Key numbers in text refer to figure 17.

1. Check connecting link (4) and crank arm (11) for wear and damage, replace as required.

2. Inspect transmission shaft (5) and bearings in mounting bracket (2) for wear and damage. Bearing bushings in bracket may be replaced using suitable replacer tool.

GEAR BOX

NOTE: Key numbers in text refer to figure 18.

1. Check gear and shaft assembly (1) for wear and damaged gear teeth. If gear or shaft is damaged assembly is replaced as a unit.

2. Inspect "Park" switch and terminal board assembly (fig. 22) for burned, broken or sticking contact points. Contact points may be cleaned using a thin, fine-cut contact file. Replace parts as required.

3. Test resistor for a shorted or open condition and replace if damaged.

NOTE: Switch assembly and resistor are replaced as a package unit.

BRUSH HOLDER PLATE ASSEMBLY

1. Check brushes and springs for wear or damage. Brushes may be replaced by unsoldering lead at circuit breaker and cutting lead at field assembly splice joint.

2. Inspect circuit breaker for open or burned contacts. Contact points may be cleaned using a fine-cut contact file.

NOTE: Brush holder plate and circuit breaker assembly are replaced as a unit package.

FIELD COIL ASSEMBLY

1. Connect test light between field coil lead splices to check for an open field assembly. If lamp fails to light replace field assembly.

2. Connect test light between field lead and case to check for grounded field. If lamp lights field is grounded and must be replaced.

ARMATURE ASSEMBLY

1. A bar to bar check with test light will indicate an open armature. If lamp does not light between any two adjacent commutator bars, armature must be replaced.

2. Connect test lamp between armature shaft and commutator. If lamp lights armature is grounded and must be replaced.

3. Test armature on growler for shorted condition.

4. Inspect armature thrust ball for pitting and wear, replace if damaged.

MOTOR BEARINGS

Check armature shaft and gear shaft bushing-type bearings in motor housing and end cap for scored or worn condition. If bearings are defective replace assembly.

ADJUSTMENTS

Armature End-Play

1. Loosen adjusting screw lock nut and tighten adjusting screw (fig. 22) until finger-tight.

2. Back off adjusting screw 1/4 turn and tighten lock nut.

Gear Assembly End-Play

NOTE: Key numbers in text refer to figure 18.

1. Remove retaining ring (4) from gear shaft (1).

2. Add end-play washers (3) as required to obtain .006" minimum end-play.

AIR HORNS

Dual air horns are mounted on brackets located in horn compartment. Horns are accessible from underneath right front corner of coach. Air pressure to horns is controlled by driver's foot control valve. Air pressure is supplied by auxiliary air system, obtained in turn, from main air system. Pressure regulating valve in air lines prevents depletion of main air system by shutting off air to auxiliary air system when pressure in main system falls below approximately 65 pounds.

Refer to BRAKES (SEC. 4) for air line diagrams and information on air lines and connections. Pressure regulating valve maintenance and repair information is also contained in BRAKES (SEC. 4).

REPAIR

Horn is non-adjustable, and requires no maintenance.

In the event of horn failure, make sure air system pressure is at least 75 pounds. If air pressure is sufficient, failure may be due to cracked diaphragm. Remove horn assembly and replace diaphragm.

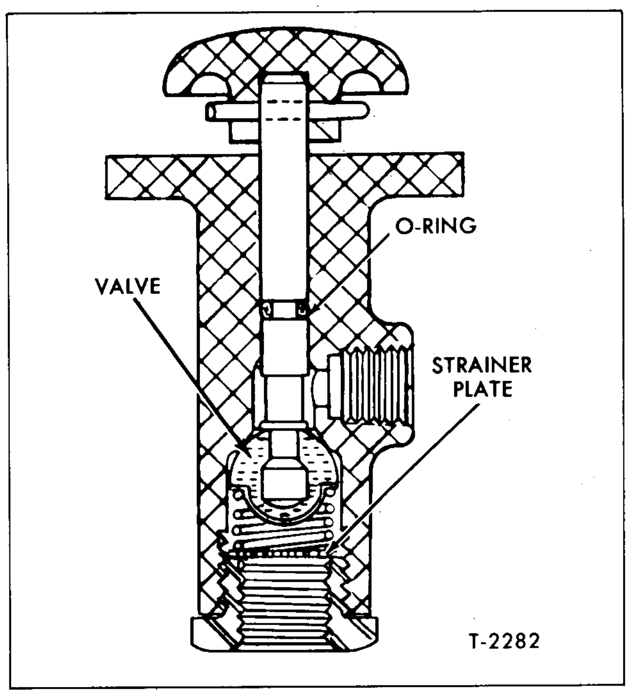


Figure 23—Air Horn Foot Valve

FOOT CONTROL VALVE (Fig. 23)

Valve, which controls operation of air horns, is mounted in driver's floor, with valve body extending downward into tool compartment. Valve requires no maintenance, but can be easily checked for leakage with soap and water solution.

If leakage does occur, valve should be disassembled and lapped, using fine valve grinding compound. After grinding, wash all parts in gasoline and blow with compressed air to remove all traces of grinding compound.

Whenever valve is disassembled, or in event of weak horn action, strainer plate should be cleaned.

ELECTRIC HORNS

Two electric horns are mounted on brackets located in horn compartment. Horns are accessible from underneath right front corner of coach. Electrical tests of horns are covered in "WIRING AND MISCELLANEOUS ELECTRICAL" (SEC. 7) of this manual.

PASSENGER SIGNAL CHIME

Passenger signal chime (fig. 24), protected by No. 23 circuit breaker in driver's control panel, is mounted on front panel at left of steering column. Chime is sounded by two switches, mounted under front ends of package racks, when "CHIME" switch on driver's control panel is in "CHIME" position. Chime circuitry is shown on "Alarm and Signal Wiring Diagram" at back of this manual.

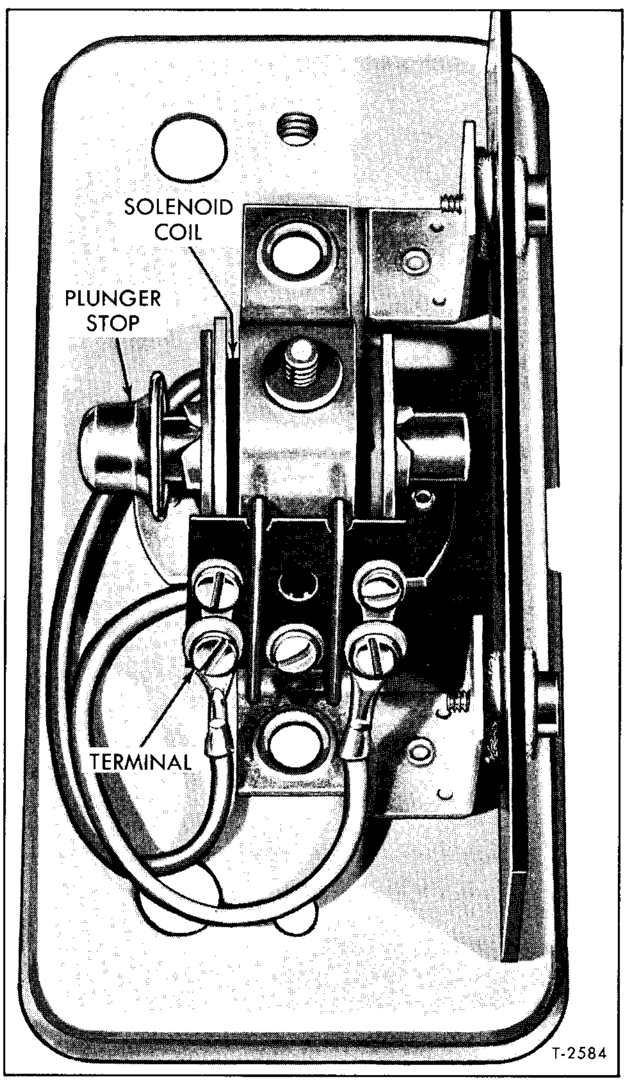


Figure 24—Passenger Signal Chime

MAINTENANCE

Solenoid-type chime has no contacts and requires no regular maintenance.

If chime fails to operate, remove chime cover and check for current indication at both terminals. If current indication is not obtained, check circuit breaker in driver's control panel. If current indication is obtained at one terminal, failure may be due to burned out coil. Current indication obtained at both terminals and chime does not sound, check operation of plunger.

If chime sounds, check circuit continuity from chime, through "CHIME" switch on driver's control panel.

If inspection indicates chime and "CHIME" switch are in operating condition, check continuity of current through the passenger signal pull-cord switch. If necessary, remove cover from pull-cord switch as shown in figure 25. Clean terminal and bolt contacts. Inspect switch contacts for loose connections. Operate pull cord and observe mechanism for possible disorder. A short piece of jumper wire placed to each terminal screw will check circuit continuity.

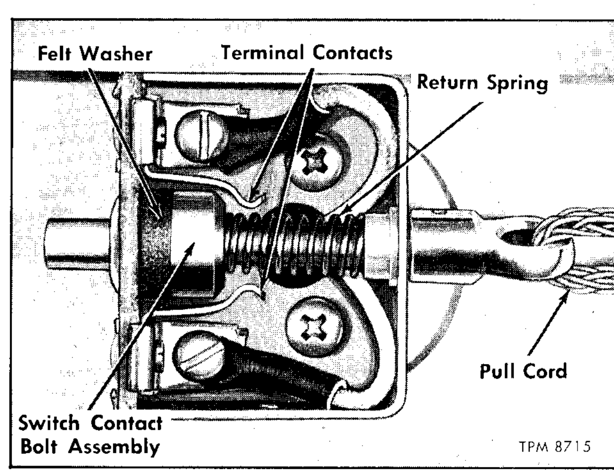


Figure 25—Passenger Signal Chime Cord Switch—Cover Removed

OUTSIDE MIRRORS

Outside mirrors (fig. 26) are equipped with replaceable glass sections which can be readily replaced if broken.

Mirror head-to-arm tension and the arm-to-coach tension are adjustable as follows:

MIRROR HEAD TENSION ADJUSTMENT

At back of mirror, tighten or loosen three screws which will tighten or loosen tension on mirror head ball stud.

MIRROR ARM-TO-BRACKET TENSION ADJUSTMENT

At body end of mirror arm, remove small screw retaining stud cap to arm stud. Remove cap. Remove pin from jam nut, then loosen or tighten jam nut to obtain desired tension.

DISASSEMBLY OF MIRROR ARM

1. At mirror end of arm, loosen set screw to remove mirror head from arm.
2. Remove small screw retaining stud cap to arm stud at body end of arm. Remove stud cap.
3. Remove cotter pin from jam nut and remove jam nut, flat steel washer and fiber washer.
4. Remove arm from stud, then remove fiber washer from arm stud bracket.

ASSEMBLY OF MIRROR ARM

Assemble arm in reverse of disassembly procedure.

MIRROR GLASS REPLACEMENT

1. Pry rubber frame from mirror head. Wearing gloves to protect hands, remove broken or discolored mirror glass from mirror head.
2. Apply mastic to edge of mirror glass and position glass in mirror head. Replace rubber frame around mirror head. At regular inspection of body check for loose bolts. Make repairs immediately.

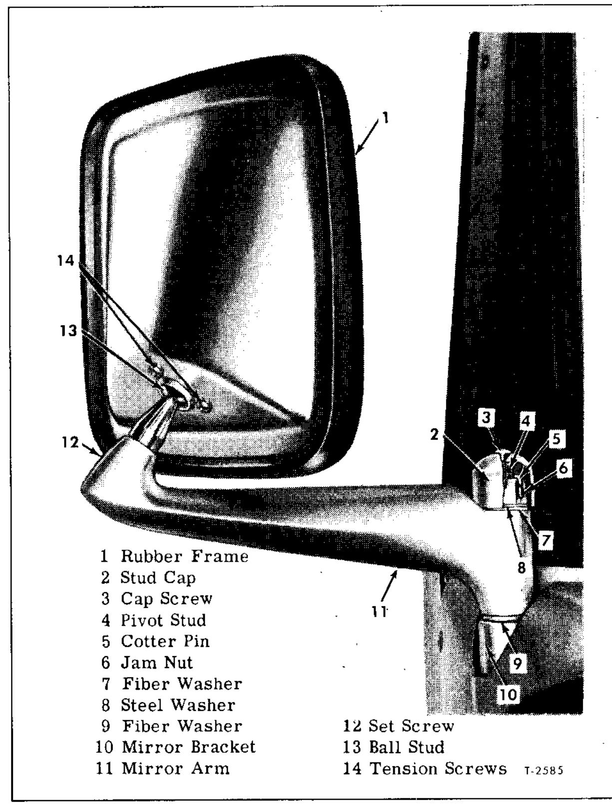


Figure 26—Outside Rear View Mirror

SPECIFICATIONS

PASSENGER SIGNAL CHIME
- GM Part Number 2455067
- Type .... Single Tone

WINDSHIELD WIPER MOTOR
- Part Number 4916971
- Type .... Two Speed
- Operating Voltage .... 12 VDC
- Current Draw (Amps.)
  - No Load (Lo Speed) .... 5.5 max.
  - (Hi Speed) .... 4.0 max.
  - Installed (Wet Windshield)
    - (Lo Speed) .... 6.0 max.
    - (Hi Speed) .... 4.5 max.
- Stall
  - Lo Speed .... 20 max.
  - Hi Speed .... 19 max.
- Crankarm Rotation .... CCW
- Speed RPM (No Load—Cold Motor)
  - Lo Speed .... 40 ± 5
  - Hi Speed .... 65 ± 5
- *Wipes/Minute (Installed—Wet Windshield)
  - (Cold Motor) Lo Speed .... 40 ± 5
  - (Cold Motor) Hi Speed .... 65 ± 5

*Wipes/Minute are counted on the basis of one (1) for each complete blade stroke, i.e., blade movement from park position to end of stroke back to park position = 1 Wipe/Minute.

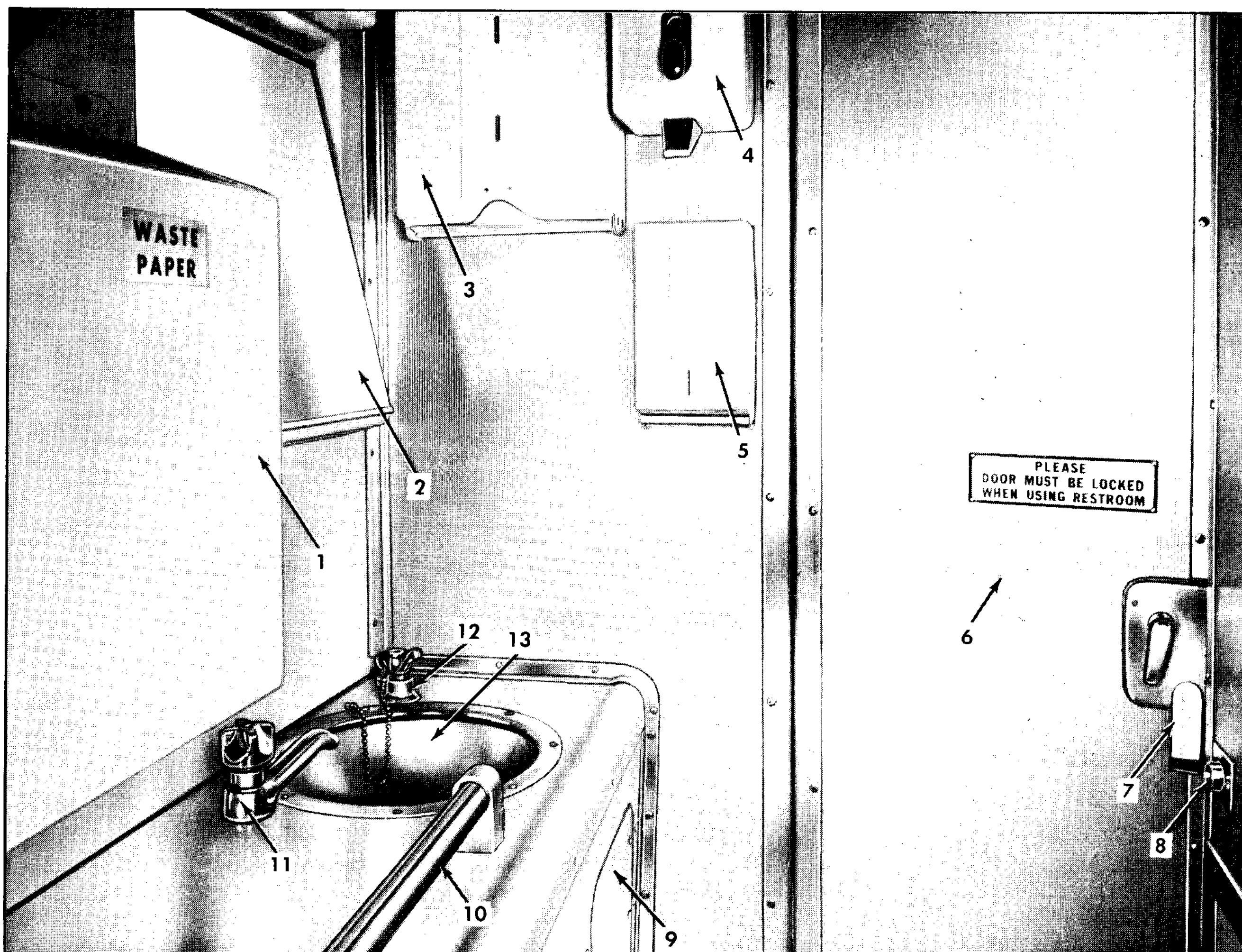
Lavatory

DESCRIPTION

Lavatory and toilet facilities are provided for passenger comfort and convenience (fig. 1) as special equipment. Lavatory is located at right rear corner of coach. Lavatory compartment is equipped with wash basin, chemical toilet, liquid soap dispenser, mirror, waste paper container, toilet tissue dispenser, paper towel dispenser, and a sanitary napkin dispenser. Figure 2 illustrates interior layout of lavatory.

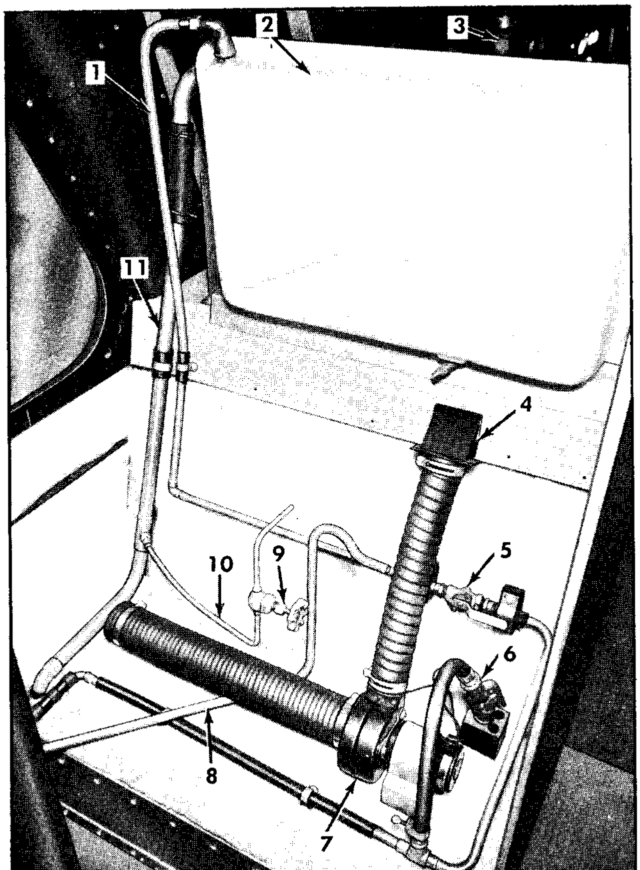
An electric motor driven blower, shown in figure 3, is used to exhaust odors from lavatory compartment. A 13.5 gallon polyethylene water supply tank, mounted behind lavatory rear wall over wash basin, supplies water to wash basin through a faucet by gravity feed.

Wash basin waste water empties into the chemical waste tank. The 22.8 gallon chemical waste tank, located directly below the lavatory compartment, has facilities for emptying beneath the coach, thus preventing odors from entering the coach.



1 Waste Paper Container
2 Mirror
3 Towel Dispenser
4 Sanitary Napkin Dispenser
5 Toilet Tissue Dispenser
6 Compartment Door
7 Compartment Door Inside Lock
8 Emergency Switch (To Signal Driver)
9 Service Compartment Access Door
10 Hand Rail
11 Water Faucet
12 Soap Dispenser
13 Wash Basin

Figure 1—General Arrangement of Lavatory



1 Water Tank Supply Line
2 Water Supply Tank
3 Water Tank Vent and Check Valve
4 Blower to Engine Air Intake Exhaust
5 Shut Off Valve
6 Cleaning Hose and Pressure Nozzle
7 Blower and Motor Assembly
8 Basin to Chemical Tank Line
9 Water Supply Tank Drain Valve
10 Water Supply Tank Drain Line
11 Water Supply Tank Overflow Line

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Figure 2—Lavatory Water Lines and Units

OPERATION

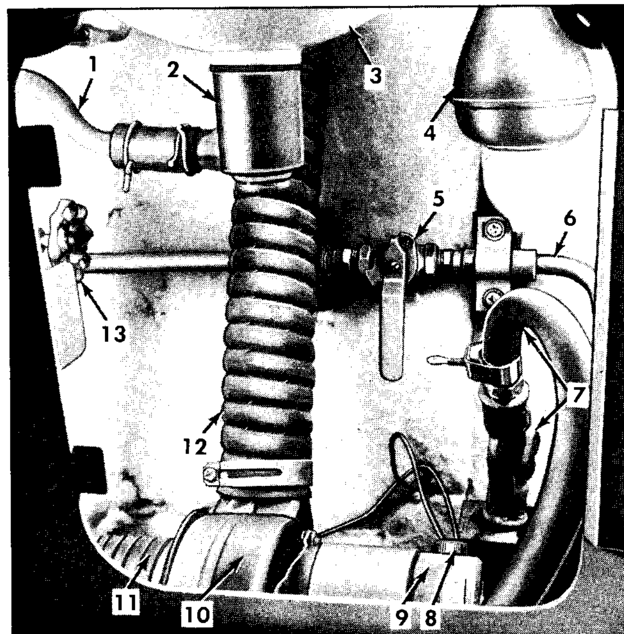
Whenever possible, automatic controls are provided for maximum passenger safety, comfort and privacy. Following information describes purpose and function of individual units.

VENTILATOR BLOWER

Ventilator blower, mounted in lavatory service compartment below the wash basin as shown in figure 3, forces odors from the lavatory compartment to the engine air intake. Blower operates continuously when "ENGINE RUN" switch is in "RUN" position.

LAVATORY EMERGENCY BUZZER

Lavatory emergency buzzer is mounted on panel under dash in front of driver as shown in figure 9 in "WIRING AND MISCELLANEOUS ELECTRICAL" (SEC. 7). Buzzer is operated by push-button type switch marked "TO SIGNAL DRIVER - EMERGENCY ONLY" located on transverse partition of lavatory compartment (fig. 1). To check circuit continuity, refer to "Lavatory Wiring Diagram - MD-97595" in back of this manual. If buzzer becomes defective, it must be replaced.



1 Basin to Chemical Tank Line
2 Wash Basin Trap
3 Wash Basin
4 Soap Supply Container
5 Shut Off Valve
6 Water Tank Supply Line
7 Cleaning Hose and Pressure Nozzle
8 Brush Cap
9 Blower Motor
10 Blower
11 Chemical Tank to Blower Intake Hose
12 Blower to Engine Air Intake Hose
13 Water Supply Tank Drain Valve

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Figure 3—Lavatory Service Compartment

DOME LIGHTS

Three dome lights are mounted on wall directly above mirror. Center light is connected to coach marker light circuit and is illuminated whenever marker lights are turned on. The other two lamps are illuminated only when lavatory is occupied and door is closed and locked. For circuit continuity refer to "Lavatory Wiring Diagram - MD-97595."

LAVATORY SIGN LIGHT

Lavatory sign light, located on transverse partition of compartment, is illuminated when lavatory is occupied, door closed, and locked. Sign reads "REST ROOM - OCCUPIED."

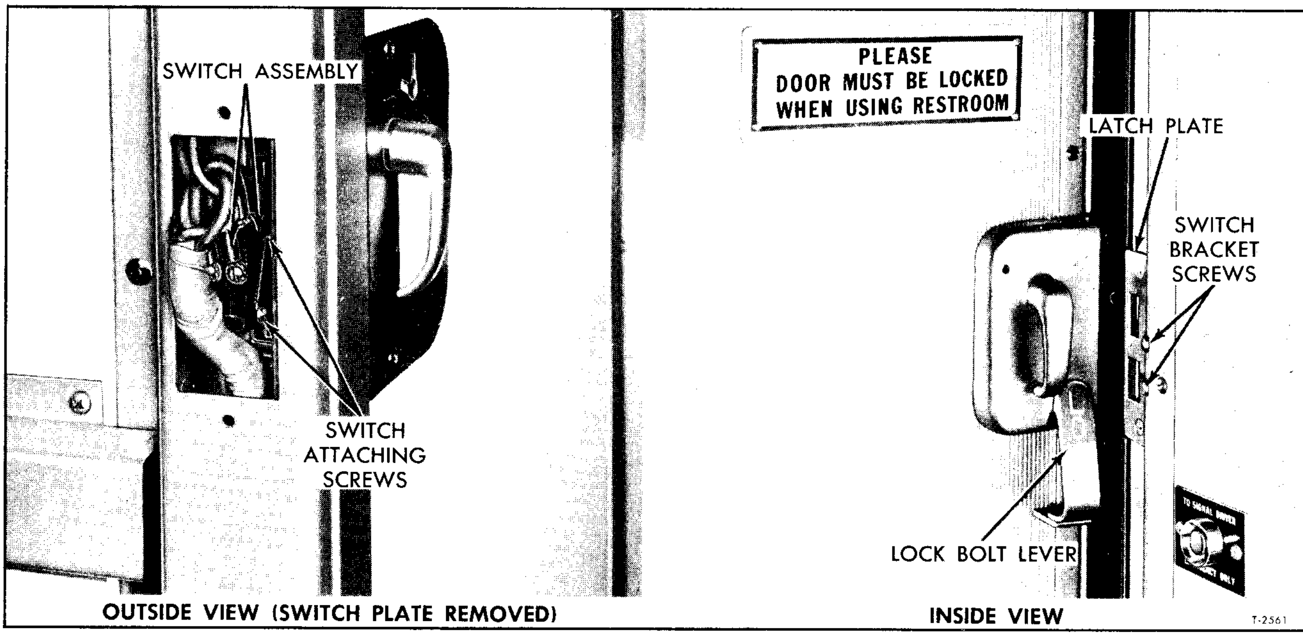


Figure 4—Compartment Door Lock and Switch Installed

LAVATORY DOOR LOCK

Door lock, installed on lavatory door, has inside and outside latch handles to open and close door as shown in figure 4. Lift up on latch when entering lavatory. In addition, inside of lock is fitted with a locking lever, which forces latch bolt outward to operate a switch in transverse partition. If locking lever fails to release, door can be opened from outside by a special key furnished to driver.

Lock assembly can be removed from door, then readily disassembled and parts replaced if necessary. Figure 5 shows backing plate removed, exposing all internal parts. A light application of Lubriplate to all moving parts will assure free operation.

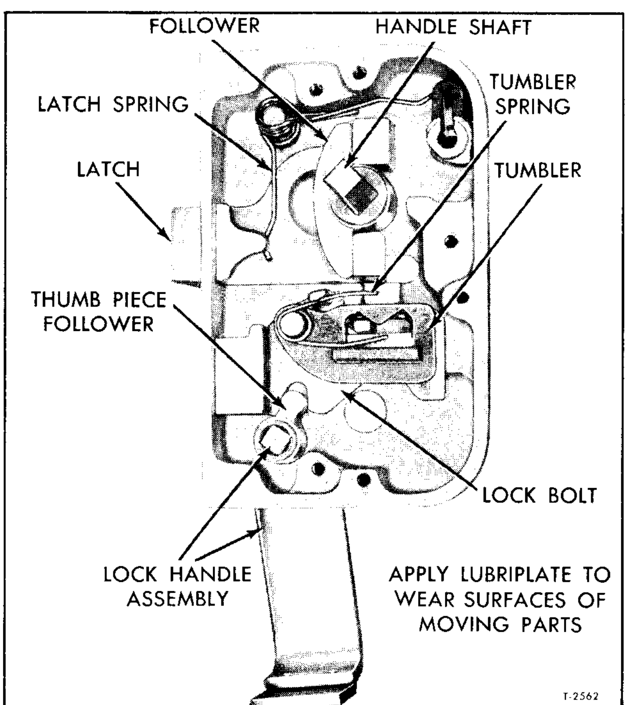


Figure 5—Compartment Door Lock Components

DOOR LOCK SWITCH

Door lock switch is "Micro" type and is installed in edge of transverse partition as shown in figure 4. Switch is closed by outward movement of door lock bolt when door is locked from inside compartment. Closing of lock switch completes electrical circuit to lavatory 15 C.P. lights and wash-room occupied sign light. For continuity, refer to "Lavatory Wiring Diagram - MD-97595" in back of this manual.

Switch mounted in partition at front of lavatory compartment door (fig. 4) is adjustable in or out to make contact with door inside lock bolt when lock lever is positioned for locking door.

Switch Adjustment (Fig. 4)

1. Remove two cross-recessed screws which attach switch cover plate to front partition, then remove plate.
2. Inside the compartment, remove two screws which attach switch bracket to partition. Pull switch and bracket from front opening.
3. Loosen two screws which attach switch to mounting bracket having two attaching screw slots purposely at back side for adjusting switch position. Squeeze bracket and switch to ends of slots.

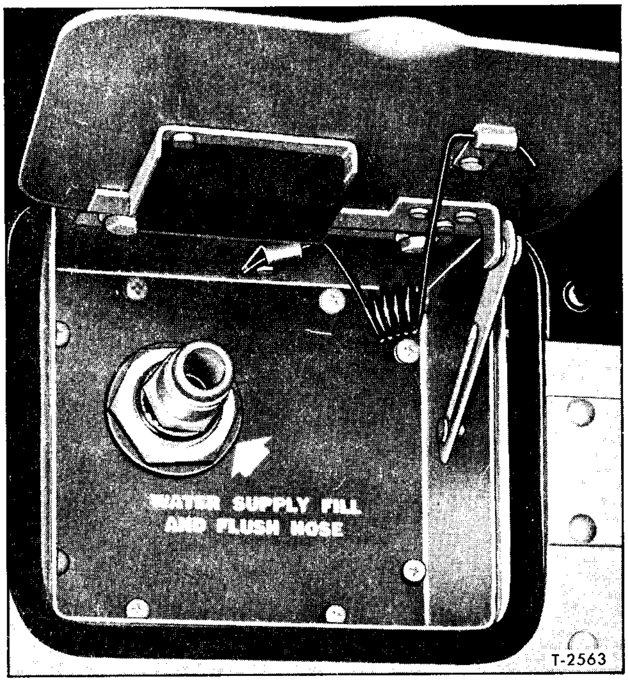


Figure 6—Lavatory Water Service Fitting

Tighten switch screws firmly, but not excessively, in nuts. Reinstall switch and bracket to partition.

4. From inside lavatory compartment, close door and lock. NOTE: Extra effort will be required to lock door first time as action will force switch to proper position on mounting bracket. Switch will be retained in position by attaching screw nuts. Check switch operation.

5. Reinstall switch cover and latch plate.

MAINTENANCE

GENERAL

Lavatory filling and flushing service line fitting is accessible after opening access door at right rear side of coach (fig. 6). End of line is equipped with a quick release coupling fitting to which a flexible service hose with a mating coupling can be attached for servicing tanks.

Hose coupling (fig. 7), which is of the Hansen 6000 Series, can be obtained at your local Hansen dealer or can be ordered from Hansen Manufacturing Co., 4031 West 150th St., Cleveland, Ohio.

Coupling hose can be purchased locally or ordered from the Gates Rubber Co., Denver, Col.

For the purpose of remotely draining the chemical tank, special connectors and fittings, shown in figures 8 and 9 are available from the Service Parts Department, General Motors Truck & Coach Division, Pontiac, Michigan.

NOTE: Instructions for draining the entire system are explained later. See "Draining of Entire Lavatory System."

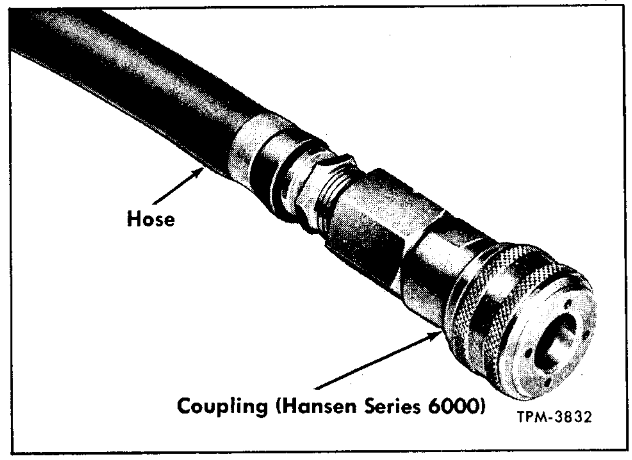


Figure 7—Service Hose and Coupling

WASH BASIN SUPPLY TANK

The polyethylene wash basin water supply tank is constructed with two fittings at top of the tank and a fitting at the side and bottom of the tank which determine the water level in tank at which the tank will overflow and the level at the outlet to the water faucet when tank is empty. Air and water is exhausted through the overflow line and a rubber trap underneath coach. The trap acts as a one-way check valve, allowing the exhaust of air and water. When water is being drained from tank by water faucet, air is admitted into tank through the check valve to displace outgoing water.

Filling Supply Tank

1. Lift access door over service line fitting at right rear of coach (fig. 6), then connect water supply hose to fitting marked "WATER SUPPLY FILL AND WASTE TANK FLUSH HOSE." Shut-off valve (5, fig. 3) must be open.

2. Fill supply tank with CLEAN, fresh water until water starts to flow out overflow line (fig. 2).

3. After filling tank, disconnect water supply hose, then close access door at service fitting.

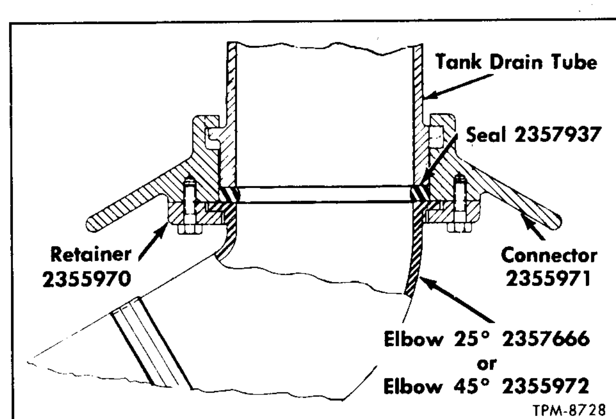


Figure 8—Chemical Tank Outlet and Quick-Lock Connector

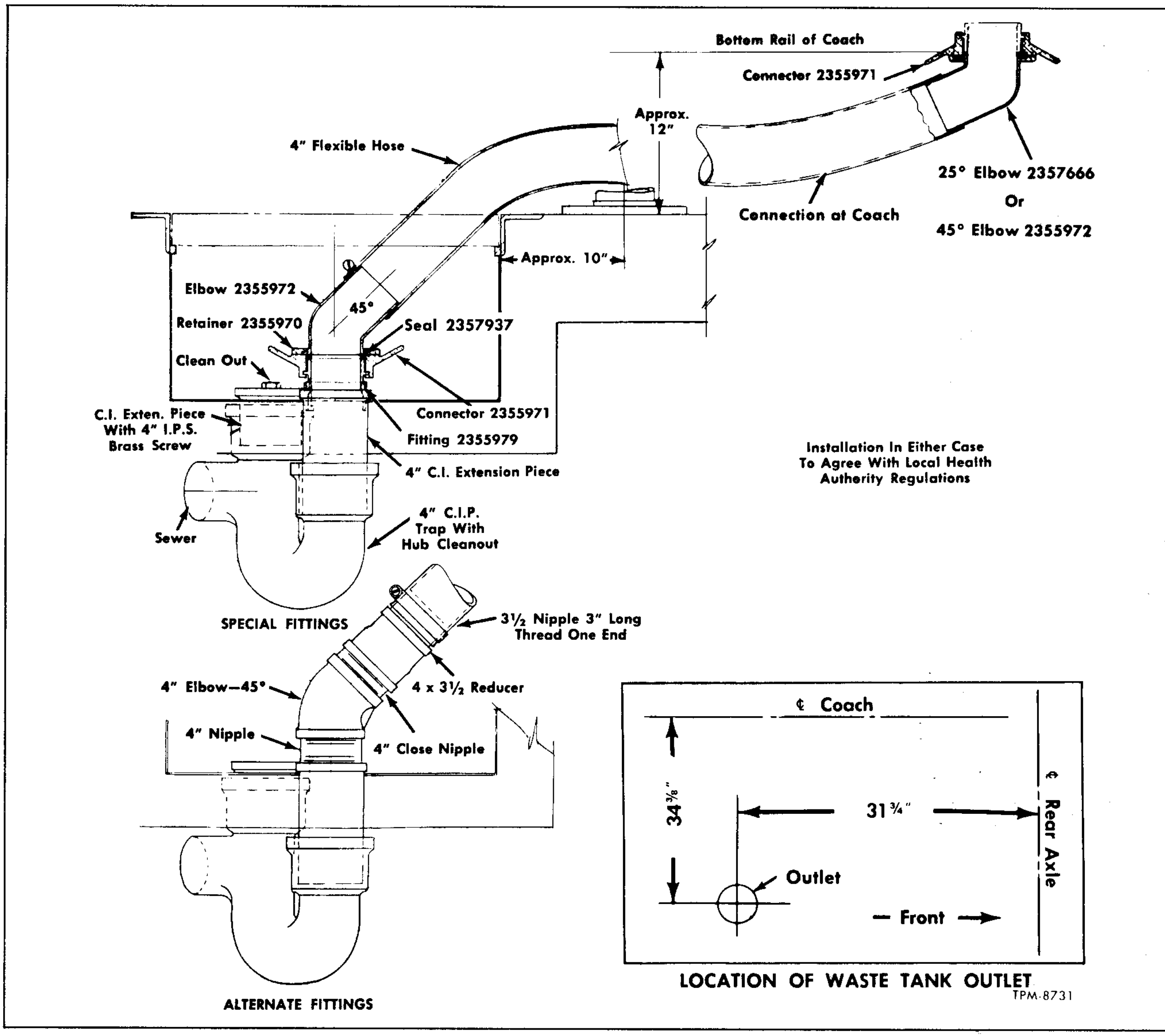


Figure 9—Chemical Tank Drain Tank Connections (Typical)

Draining Water Supply Tank

1. In service compartment, open water supply tank drain valve under wash basin and allow water to drain into overflow line.
2. If tank is to be flushed out, leave valve open and flush out tank, using same procedure as for filling supply tank explained previously.
3. After either draining or flushing of tank, close valve.

LAVATORY CHEMICAL TANK

Draining Chemical Tank

1. Place coach over sewer opening and attach drain hose special quick-lock connector to tank outlet (figs. 8 and 9). If receptical or sewer facilities are not available, comply with local health regulations.
2. In lavatory compartment at front side of stool cover, open the chemical tank drain plug handle access cover (fig. 10). Pull handle up approximately six inches as shown; this action lifts large rubber drain plug (fig. 11) from opening in bottom of tank and permits tank to empty.
3. Leave drain plug out of tank drain opening until flushing operation is completed.

Flushing Chemical Tank

NOTE: Make sure chemical drain plug is removed from bottom of tank.

1. Open small door on riser panel at right of basin and turn water supply valve handle down to the close position.
2. Lift access door over service line fitting at

right rear of coach (fig. 6), then connect water supply service hose to fitting.

3. Open water pressure into fitting, then within the lavatory compartment, open small door on riser panel at right of basin (fig. 3) for access to flexible flushing hose.

4. Remove hose from compartment, then direct water spray into toilet stool and chemical tank until flushing is completed.

5. Leave water supply service hose connected until after tank is chemically treated.

Sealing Chemical Tank

1. Press chemical tank drain plug handle (fig. 10) down until handle rod stop is seated firmly to seal retainer. This action will position drain plug into tank drain opening as shown in figure 11.

NOTE: If stop is positioned on handle rod to dimension shown, proper plug location in drain tube will be obtained. Close handle cover.

2. Underneath coach, disconnect tank drain hose (fig. 8) (if used).

3. If tank drain plug does not seal satisfactory, expand plug diameter as directed below under "Chemical Tank Drain Plug Adjustment."

Chemical Tank Drain Plug Adjustment

Adjustment is made underneath coach at lower end of drain plug (fig. 11).

1. To prevent drain plug rod from turning while making adjustment, have assistant hold the drain plug handle in lavatory compartment.

2. Underneath drain plug, loosen lock nut, then turn adjusting nut until plug is expanded to a diameter which will provide a complete seal at opening. Turning adjusting nut clockwise will expand plug. Tighten lock nut firmly after making adjustment.

Filling and Treating Chemical Tank

NOTE: Before performing operation, make sure chemical tank drain plug is properly installed.

1. Using hose (fig. 3) located in compartment under wash basin, fill chemical tank through lavatory stool with approximately 2.6 gallons of water. Tank holds approximately 22.8 gallons; however, it should only be partially filled as recommended.

NOTE: During operation in freezing weather, chemical tank can be serviced with salt water to prevent freezing.

2. After filling chemical tank, return hose to holder and turn water supply valve handle up to open position.

3. Pour 2-1/2 pints of degerm chemicals into chemical tank through lavatory stool. Degerm chemical can be obtained from the Century Chemical Products Company, 520 West Fort St., Detroit, Michigan, and can be procured in 5 gallon cans, or 15, 30, and 55 gallon drums.

This chemical, mixed with water, will properly treat chemical tank.

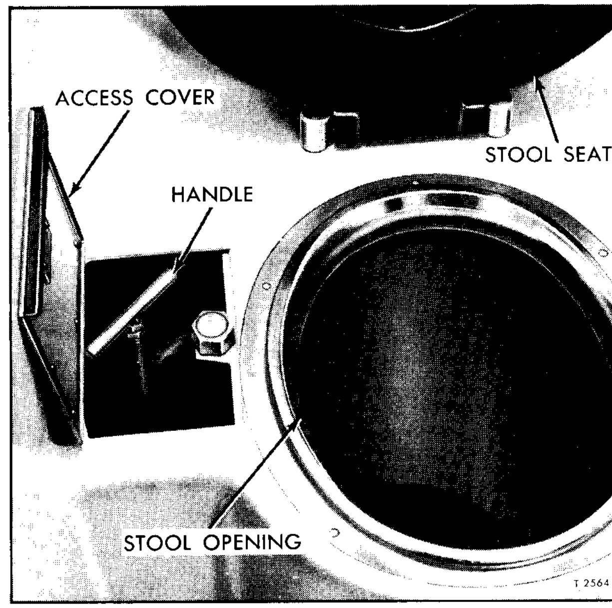


Figure 10—Access to Chemical Tank Drain Plug Handle

DRAINING OF ENTIRE LAVATORY SYSTEM

System can be drained to prevent freezing or for other reasons as follows:

NOTE: Key numbers in text refer to figure 2.

1. Place vehicle over proper drain catching

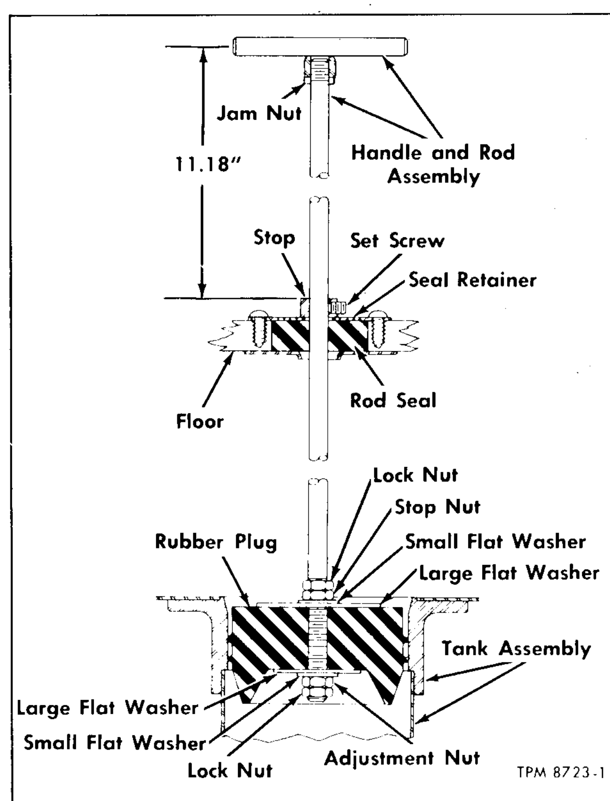


Figure 11—Chemical Tank Drain Plug and Handle Installation

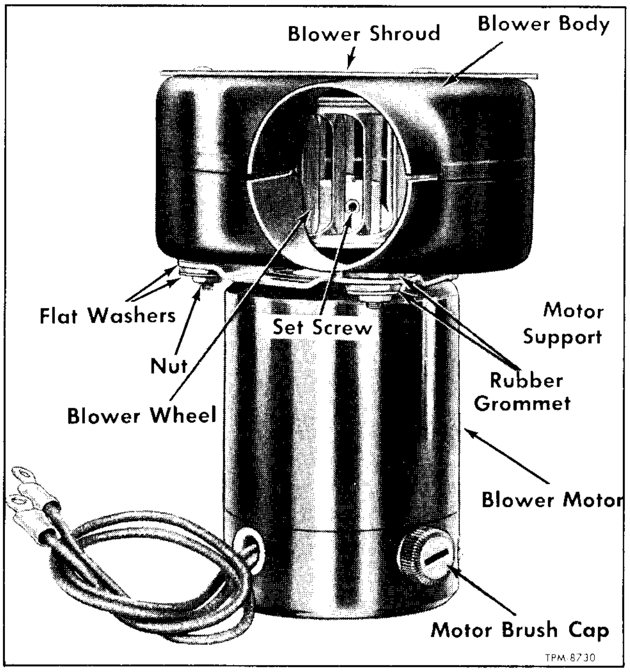


Figure 12—Blower and Motor Assembly Removed

facilities to comply with local health regulations.

2. Drain chemical waste tank by pulling up on drain plug handle accessible within lavatory compartment at front of stool. Leave handle in raised position.

3. Through access door below wash basin, open water supply tank drain valve (9) allowing tank to drain into overflow line. Leave valve open until system is to be refilled.

VENTILATING BLOWER AND MOTOR

Ventilator blower and motor is mounted at right side of service compartment and is accessible after opening the small door on riser panel at right side of wash basin (fig. 3).

Blower motor brushes can be replaced without having to remove unit from mounting.

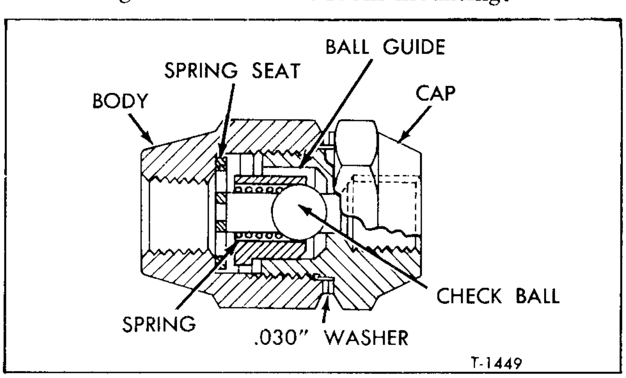


Figure 13—Water Supply Tank Check Valve

Blower and Motor Removal

1. Open service compartment door on riser panel at right side of wash basin.

2. Disconnect wiring and tape connection.

3. Loosen clamp attaching large flexible air inlet hose to blower shroud and remove hose.

4. Loosen clamp at blower shroud air outlet to engine air intake hose and remove hose from blower shroud.

5. Remove two bolts which attach blower assembly mounting clamp to mounting bracket, then remove motor with fan and housing assembly.

Blower Motor Installation

1. Place blower motor with fan and housing in position, then attach to mounting bracket with clamp.

2. Install large flexible air inlet hose to blower shroud and attach with clamp.

3. Install flexible air outlet hose to blower shroud and attach with clamp.

4. Connect electrical wiring. IMPORTANT: Tape wiring connections securely.

5. Check motor operation.

Disassembly and Assembly (Refer to Fig. 12)

1. Remove three screws which attach blower shroud to blower body. Remove shroud.

2. Loosen set screw which secures blower wheel to motor shaft.

3. Remove three nuts which attach blower body and mounting bracket to motor support.

4. Pull blower wheel from motor shaft being careful not to distort wheel. Separate parts.

5. Reassemble blower and motor in reverse sequence of above. Position rubber grommets and flat washers as shown. Before tightening blower wheel to blower shaft set screw, make sure blower wheel, when turning will not contact blower body.

WASH BASIN SUPPLY LINE CHECK VALVE

Check valve (fig. 13) is installed in top of wash basin water supply tank mounted behind lavatory compartment rear upper closure panel.

Valve is a ball type and opens when water is drawn from the faucet to maintain pressure within the tank.

The valve should be periodically cleaned and inspected as follows:

Removal

1. Remove screws to disengage lavatory rear panel.

2. Open rear section of side window in lavatory compartment and slide panel toward side window and front of coach far enough to reach mirror light, ventilating motor and door buzzer wiring harness over top of panel.

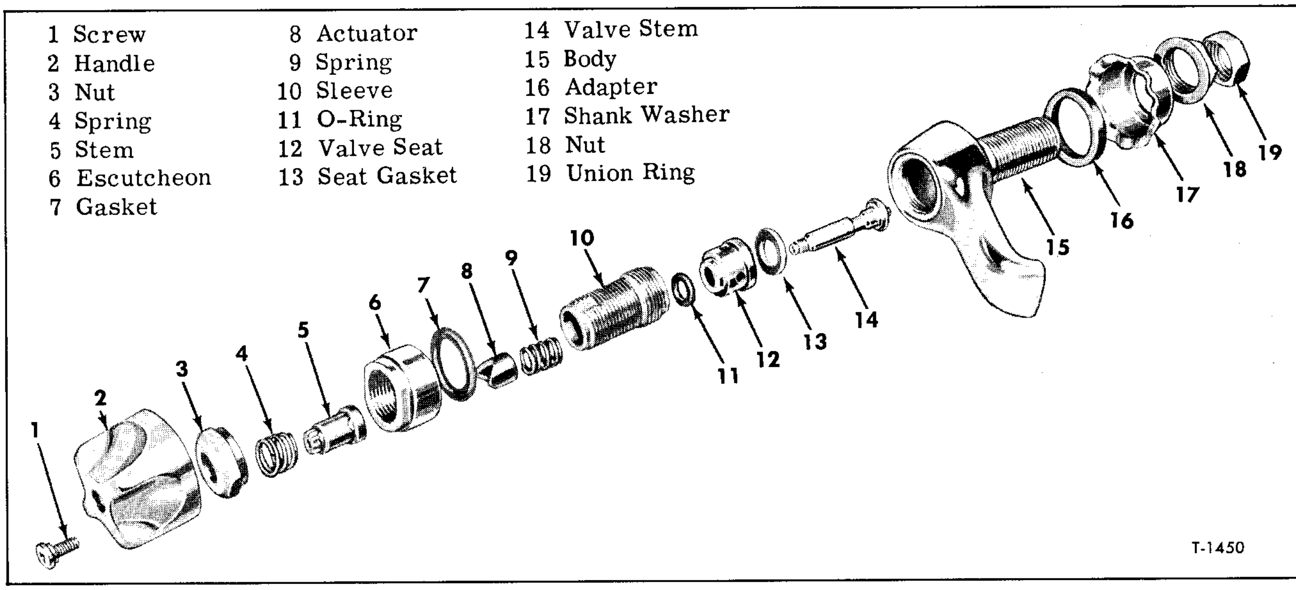


Figure 14—Water Faucet Components

3. Disconnect wiring harness connectors, then remove panel.

4. Remove check valve and elbow assembly from top of water supply tank, using extreme care not to disturb threaded connection at tank.

5. Use two 1-1/8 inch open-end wrenches to separate valve body and cap assembly.

6. Examine check ball, spring and disc for pitted or damaged condition. Replace check ball if necessary.

Installation

1. Clean out check valve body, cap and elbow, then install check ball, spring and seat in body.

2. Place one washer between body and cap. Thread valve body into cap and tighten.

3. Place a suitable sealer on threads of valve stem and reinstall in top of water supply tank. Tighten firmly.

NOTE: When reinstalling valve, make sure arrow on side of valve is pointing toward tank elbow.

4. Place rear panel in position, install wiring harness to top of panel; then rotate screws to engage panel fasteners.

WASH BASIN WATER FAUCET

The gravity feed wash basin water faucet, shown in figure 1, may be removed for cleaning or repair as explained below:

Removal

Key numbers in text refer to figure 14.

1. Open water drain valve in service compartment to completely drain wash basin supply tank.

2. Open service compartment access door (fig. 1) to gain access to water faucet fittings.

3. Remove union ring (19), then disconnect water supply line from water faucet.

4. Remove mounting nut (18), shank washer (17), and adapter (16) which attach the faucet assembly to the wash basin trim panel.

Installation

Key numbers in text refer to figure 14.

1. Place faucet assembly through opening in wash basin trim panel and position as shown in figure 1.

2. Place adapter (16) over threads of faucet.

3. Place shank washer (17) over faucet mounting threads and position against wash basin trim panel, then install mounting nut (18); tighten firmly.

4. Place water supply line through union ring (19) and seat into body of faucet. Tighten union ring firmly.

Disassembly

Key numbers in text refer to figure 14.

1. Remove screw (1), then remove handle (2) from stem (5).

2. Remove nut (3) from escutcheon (6), then remove stem (5) and spring (4).

3. Remove escutcheon (6) from sleeve (10).

4. Remove sleeve (10) from body (15), then hold valve stem stationary and remove actuator (8) and spring (9).

5. Press valve stem from sleeve (10).

6. Examine O-ring and gaskets for worn or damaged condition. Clean all threaded areas thoroughly. Replace valve stem and seat if excessively pitted.

Assembly

Key numbers in text refer to figure 14.

1. Place O-ring (11) against seat of sleeve (10).
2. Position lip of valve seat (12) against O-ring (11) in sleeve (10), then place gasket (13) against seat (12).
3. Press valve stem (14) into sleeve (10) until tight against gasket (13), then install spring (9) over valve stem.
4. Hold valve stem and install actuator (8) on valve stem. Tighten firmly.
5. Thread sleeve (10) into faucet body (15) and tighten firmly.
6. Place gasket (7) over sleeve (10), then install escutcheon (6) and tighten firmly.
7. Place spring (4) over stem (5), then install against actuator (8). Install nut (3) and tighten firmly.
8. Install handle (2) and secure to valve stem with screw (1).

SPECIFICATIONS

WATER SUPPLY TANK
Capacity . . . . 13.5 gal.

CHEMICAL WASTE TANK
Total Capacity . . . . 22.8 gal.
Water Required After Cleaning . . . . 2.6 gal.

VENTILATING BLOWER MOTOR
GM Part Number 2361146
Make . . . . Universal Electric
Model 4-107-9
Type . . . . Series Wound
Volts . . . . 12 DC
Amperes 3
Rotation (Shaft End) . . . . Clockwise
RPM 3000

PASSENGER EMERGENCY SIGNAL BUZZER
Make . . . . Delco-Remy
GM Part Number 1116882

Brakes

This group contains maintenance and repair information on BRAKES. The five sections of the group are shown in index below:

General

AIR SYSTEM DESCRIPTION

Air system in coach is made up of a group of devices. Some of these devices maintain a supply of compressed air, some direct and control the flow of compressed air, and others transform energy of compressed air into the mechanical force and motion necessary to accomplish their particular function. Only those units with functions directly related to the vehicle braking system are covered in this section. Information on other air system units will be found in other sections of this manual as shown later under "Index of Air Control Units."

To simplify the description and operation of the air system (fig. 1), it is divided into five interconnected systems: the air supply and control system, the air suspension system, the service brake air system, the DD3 parking and emergency air brake system, and the accessories air system.

AIR SUPPLY AND CONTROL SYSTEM

The air supply and control system supplies and controls air pressure for operation of all systems. This system consists of the air compressor and governor, air line test valve, check valves, safety valves, low air pressure indicator sending unit, main (wet-dry) air tank, front air tank, pressure regulating valve, and emergency tank. Operation of air compressor and governor is described in "AIR COMPRESSOR AND GOVERNOR" section later in this group.

AIR SUSPENSION SYSTEM

The air suspension system is supplied air from the front air tank through a pressure regulating valve. This system includes height control valves and air bellows. The air suspension system is fully described and illustrated in AIR SUSPENSION (SEC. 14) of this manual.

SERVICE BRAKE SYSTEM

The service brake system is supplied air from both the front and main air tanks. The system includes the brake application valve, stop light switch, rear brake relay valve, front brake chambers, and service port of the rear (DD3) brake chambers.

DD3 PARKING AND EMERGENCY BRAKE SYSTEM

The DD3 system is supplied air from the emergency air tank. This system includes the DD3 control valve, low air indicator sending unit, inversion valve, and rear (DD3) brake chambers (actuators).

Of these three units the actuator is used by either the service or parking systems, while the other units are used wholly by the parking system to operate the foundation brakes. These three units are used in conjunction with a standard foot control valve and a slack adjuster connected to standard cam-operated wheel brakes.

The name of the system is derived from the description of the actuator (chamber). "DD" describes the double diaphragm and the suffix "3" denotes the triple action for service, parking and emergency braking. The actuator functions normally as a service brake chamber, but in addition has a means of mechanically locking a brake application so it can be used for parking. The DD3 brake actuator is used only at the rear wheels. Standard air-operated chambers are used at the front wheels.

ACCESSORIES AIR SYSTEM

Various accessories and standard items are air-operated. These units are supplied air from the various tanks, e.g., air horn from the front air tank, engine shutter control from the main air tank, etc. An index follows this section listing the various air-operated devices and control units incorporated in the coach and the sections in which

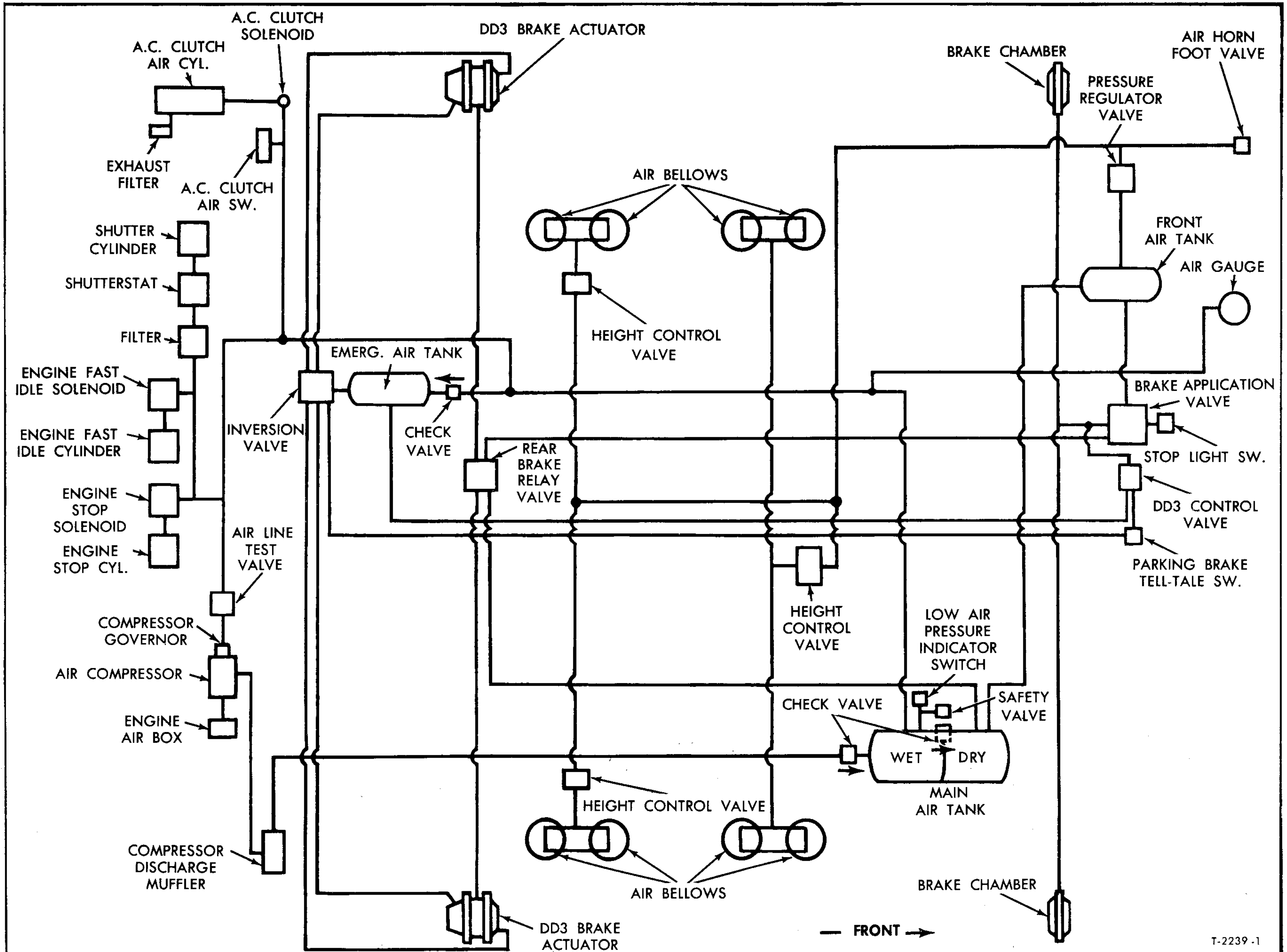


Figure 1—Schematic Air Line Diagram

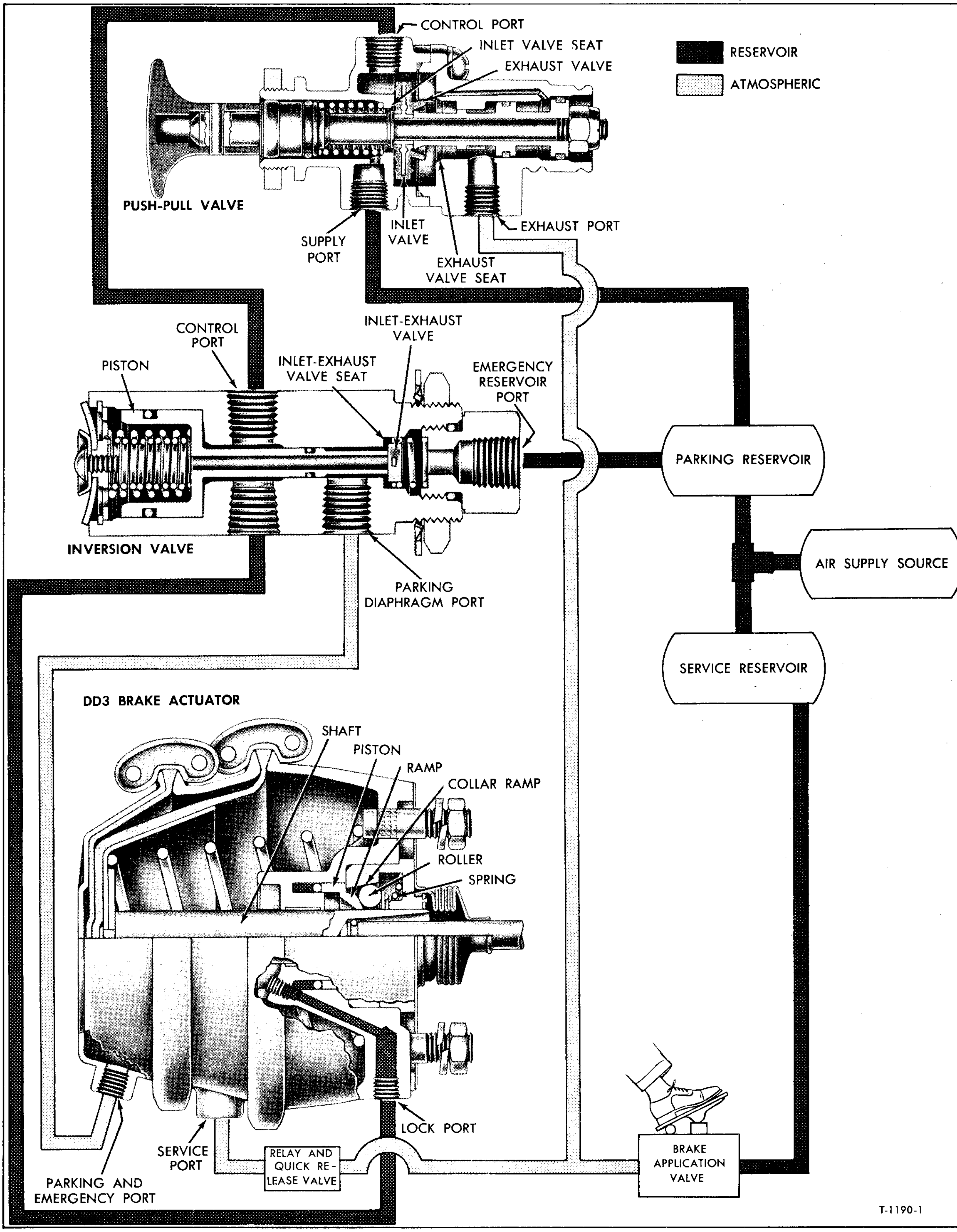


Figure 2—Schematic Diagram of DD3 Brake Actuator System

the operation and maintenance procedures of these units are described.

AIR SYSTEM OPERATION

MAIN AIR SYSTEM (Fig. 1)

Compressed air, supplied by the air compressor, is discharged through the discharge muffler into the wet side of the main air tank. A one-way check valve in the air supply line allows air to flow into the tank, but prevents loss of air in the event of a leak or break in the air line between discharge muffler and wet tank.

A one-way check valve installed in main air tank permits air to flow from wet side to dry side of tank. Low air pressure switch and safety valve are connected to wet side of main air tank. The low air indicator provides a warning to driver if pressure drops below 60 psi. Safety valve vents air through the exhaust port if tank pressure exceeds 140 to 160 psi. Front air line of dry tank supplies air to front air tank, and rear air line of dry tank supplies air to rear brake actuators through the rear brake relay valve.

The emergency tank supplies air for the DD3 parking and emergency brake. The front air tank supplies air directly to the brake application valve, and to the air suspension and air horn through a pressure regulating valve. Regulating valve supplies air only when pressure in front tank is at least 65 pounds. An air gauge mounted in the instrument panel allows driver to observe exact air pressure at all times.

AIR SUSPENSION SYSTEM

Complete operation and maintenance procedures for air suspension system and its components are given in AIR SUSPENSION (SEC. 14).

SERVICE BRAKE SYSTEM

When brakes are applied, air pressure from front air tank passes through the brake application valve to the stop light switch, front brake chambers, and rear brake relay valve. Pressure to relay valve actuates the valve, permitting air pressure direct from the dry tank to pass through the valve to the service port of the rear brake chambers (actuators). Movement of front and rear brake chamber push rods is transmitted to the brake shoes through slack adjusters and camshafts.

When brakes are released, air in rear brake chambers is exhausted at the rear brake relay valve. Air in front brake chambers, stop light switch and line to relay valve is exhausted at the application valve.

DD3 PARKING AND EMERGENCY BRAKE SYSTEM

Service Brake Operation

Figure 2 shows schematically how the system works. With the handle of the push-pull control valve pushed in, air pressure from the emergency reservoir is delivered through the push-pull control valve to the control port of the inversion valve. From there it is routed to the lock port of the DD3 brake actuator. Air pressure, acting on the actuator piston, moves it forward to contact the rollers which roll up the ramp of the piston, holding them away from the push plate shaft. This allows the push plate and shaft to move freely in both directions for normal service brake application and release as previously described.

Parking Operation

To park, the handle of the push-pull control valve is pulled out. This action closes the inlet valve, closing off any further air supply to the push-pull valve control port (and from there through the inversion valve to the DD3 brake actuator lock port). At the same time, this "pulling out" action opens the exhaust valve of the push-pull control valve, which allows the lock port of the DD3 brake actuator to vent through the control port of the inversion valve and then through the push-pull control valve and the open exhaust port of the foot control valve.

When the DD3 brake actuator lock port is vented, the roller spring forces the rollers against the ramp on the collar to engage them with the push plate shaft.

When the control port of the inversion valve is vented, the inversion valve piston moves forward and opens the inlet-exhaust valve. This opens the line from the parking reservoir and allows air pressure to flow into the parking port of the DD3 brake actuator. Full parking reservoir pressure is delivered and a parking brake application results. With the rollers against the shaft, the shaft can move forward but is locked so that it cannot return for release. To release parking application it is necessary to have full pressure in the air system; "push in" on push-pull control valve (make sure it stays "in") and make a full 100 psi service brake application.

Emergency Operation

The vehicle is equipped with an air pressure gauge (in the instrument cluster) and a low air pressure buzzer. When the operator is aware of a loss of air pressure as indicated by the gauge or the buzzer, and the service brakes will not stop the coach, a manual emergency application of the parking brake should be made by pulling out the handle of the push-pull control valve. Brakes then operate as described under the heading of "Parking Operation."

In the event the operator does not respond to the warning system or if the system fails to function, or if the loss of air pressure is too sudden

for action, and if the air pressure in the parking reservoir falls below 40 psi, the push-pull control valve will automatically "pop" out, causing pressure in the DD3 actuator lock port to exhaust, which will result in an automatic parking (emergency) brake application.

INDEX OF AIR CONTROL UNITS

*Special equipment.

Air Supply and Control

AIR COMPRESSOR DISCHARGE MUFFLER

Air compressor discharge muffler (fig. 1), mounted in engine compartment above air compressor, is connected by a flexible air line to the air compressor discharge fitting. Purpose of muffler is to arrest the pulsation noises (ping) caused by discharge of compressed air from the reciprocating air compressor.

Since the discharge muffler is the first unit hot compressed air enters, considerable condensation collects in the unit. This condensation must be drained daily. Drain cock and drain tube are installed at lower side of muffler. Drain cock valve is open with handle at right angle to valve body, and is closed with handle parallel to body.

Muffler should be removed at regular intervals and the inside cleaned of carbon deposits or other foreign material.

AIR LINE TEST VALVE

An air line test valve installed in air line in top of engine compartment (fig. 1), is used primarily to keep the air suspension system inflated during long periods while coach is standing still. However, valve can be used to check air system pressure, by using an ordinary tire gauge.

CHECK VALVES

One-way check valves (figs. 2 and 3) are installed at the air inlet port of the wet tank and at the air inlet of the emergency tank. In the event of leakage or breakage in the air compressor discharge line, check valve at wet tank prevents the loss of air from the service brake system. Check valve at emergency tank prevents air loss from DD3 brake system in the event of leakage in serv-

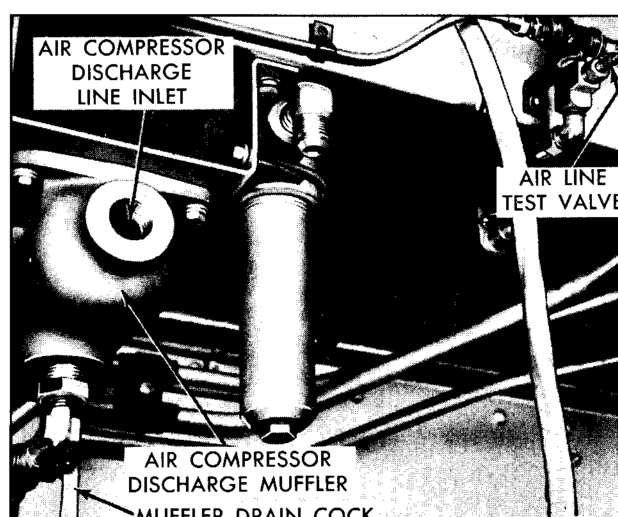


Figure 1—Air Compressor Discharge Muffler Installed

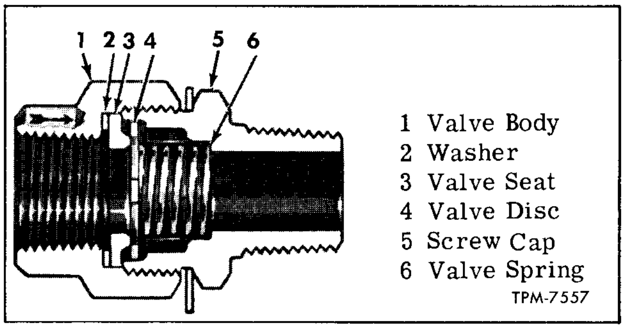


Figure 2—Air Supply Line Check Valve

ice brake system. (A check valve is also installed in main air tank as described later in this section under "Air Tanks.")

Check valve should be removed, disassembled, and cleaned at regular intervals. The rubber valve seat should be replaced if there is any evidence of deterioration or hardening. Valve spring should be replaced if weakened by rust or corrosion. See "Specifications" at end of this section. Valve disc should be perfectly smooth and free of rust or corrosion. When installing check valve, make sure it is installed to permit air flow into the air tank.

AIR TANKS

Three air tanks are used in vehicle air system, a main (wet-dry) tank, a front tank, and an emergency tank. Air tanks are connected as shown in Air Line Diagram (fig. 1 in "GENERAL" section of this group).

The purpose of the air tanks is to provide a place to store compressed air so that there will be an ample supply available for immediate operation of brakes and other air-operated equipment. Air tanks also provide storage for sufficient compressed air for several brake applications with engine stopped.

Another purpose of the tanks is to provide a place where the air, heated during compression, can cool and the oil and the water vapors can condense. Most of this condensation takes place in the rear or "wet" tank. THE MAIN TANK AS WELL AS EMERGENCY AND FRONT AIR TANKS MUST BE DRAINED EACH DAY. To drain tanks properly, leave the drain cocks open until all air escapes and until draining stops. In cold weather, particular attention should be given to draining of condensed moisture from air system. For protection in extremely cold weather, an alcohol evaporator should be used to introduce alcohol vapor into air system.

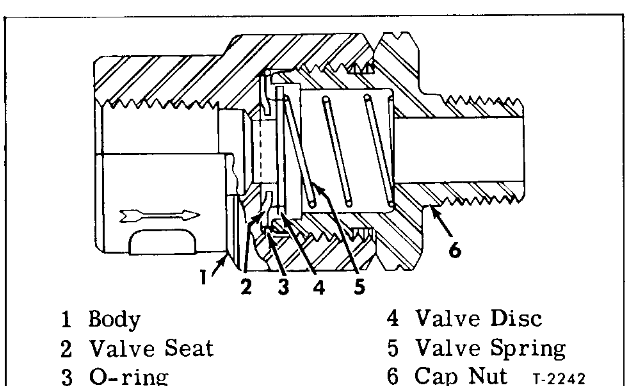


Figure 3—Emergency Tank Check Valve

All air tank mounting bolts should be checked for looseness at regular intervals, and tightened if necessary. Air tanks may be cleaned inside using steam or hot water. Inspect tank for corrosion or other damage. If corrosion or other damage has weakened the tank, it must be replaced. Location of each air tank is described below.

MAIN TANK

Main tank is actually a dual chamber unit incorporating a wet tank and dry tank. Main tank is installed horizontally behind fuel tank. Wet side of tank is at rear. Both wet and dry tanks are provided with a separate drain cock. Drain cock is closed with handle parallel to valve body, and is opened with handle at right angle to body. Figure 4 shows main air tank and associated control components installed.

FRONT TANK

Front air tank is mounted vertically in compartment at left front corner of the vehicle. Drain cock is located at bottom of tank. Drain cock valve is closed with handle parallel to valve body and is opened with handle at right angle to valve body.

EMERGENCY TANK

Emergency air tank is mounted vertically in center of coach ahead of rear axle. Drain cock is located at bottom of tank. Drain cock valve is closed when handle is parallel to valve body and is opened with handle at right angle to valve body.

MAIN AIR TANK CHECK VALVE (Fig. 5)

A check valve is installed in the top of the main air tank. Check valve permits air to flow from wet to dry chamber. In the event of leakage or breakage in the wet chamber of the tank or the supply line from wet tank to emergency tank and governor, check valve prevents air loss from dry tank.

Check valve should be removed, disassembled and cleaned at regular intervals. The rubber valve should be replaced if there is any evidence of deterioration or hardening. Valve springs should be replaced if either is weakened by rust or corrosion. See "Specifications" at the end of this section. Valve seat should be smooth and free of rust or corrosion. Replace cap grommet and valve seat O-ring with new parts.

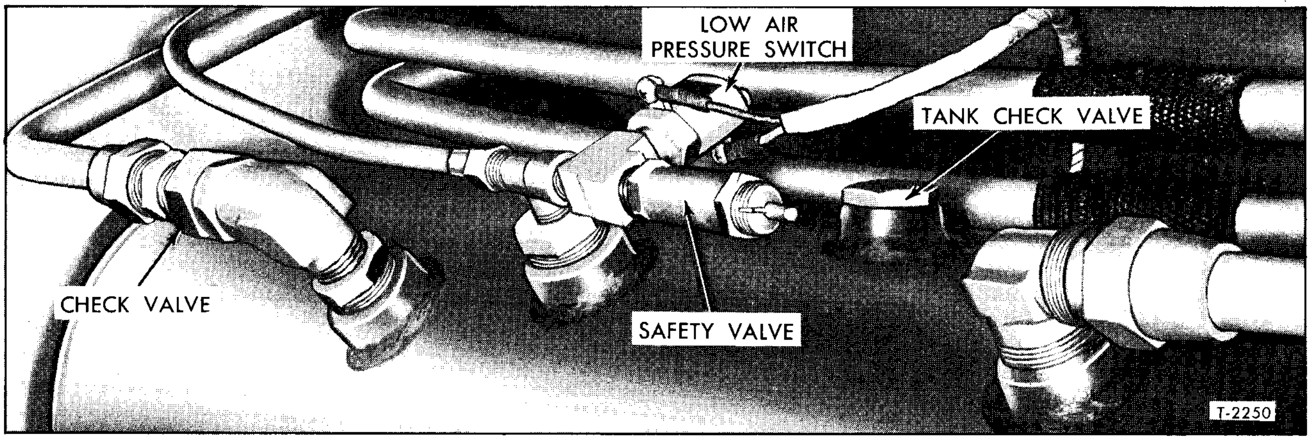


Figure 4—Main Air Tank and Control Units Installed

LOW AIR PRESSURE SWITCH

Low air pressure switch is a safety device designed to automatically give a warning when pressure in air system falls below a safe limit for brake operation. The low air pressure switch is actually an air controlled switch in an electrical circuit, automatically controlling a tell-tale light and buzzer. Low air pressure switch is installed on top of main air tank (fig. 4). Operation of tell-tale light and alarm buzzer is explained in "WIRING AND MISCELLANEOUS ELECTRICAL" in ELECTRICAL (SEC. 7) of this manual. Refer to "Alarm and Signal Wiring Diagram" in the back of this manual for electrical circuits.

OPERATION (Fig. 6)

When system air pressure under the diaphragm is above 60 pounds, force exerted by the air pressure overcomes force exerted by the diaphragm spring above the diaphragm, and electrical contacts open.

When air pressure drops below 60 pounds, the diaphragm spring exerts a force above the diaphragm which is greater than force exerted by air pressure below the diaphragm. This will cause the diaphragm to move down and close the electrical contacts. This completes electrical circuit to buzzer and tell-tale light, informing driver of his impending loss of air pressure.

The nominal pressure setting of 60 pounds is subject to a tolerance of plus or minus 6 pounds so that the actual operating pressure of the low air pressure switch may vary between 66 pounds maximum and 54 pounds minimum.

SERVICEABILITY TESTS

1. Operating Test

Operation of the low air pressure switch may be checked by reducing the system pressure and being sure that the contacts close when reservoir pressure is between 66 pounds maximum and 54 pounds minimum. The contacts will be closed when the tell-tale light and electrical buzzer operate.

2. Leakage Test

A small vent hole is provided in the cover of the low air pressure switch to check condition of the diaphragm. Cover vent hole with soap suds. If a leak is indicated it signifies a leaking diaphragm. The diaphragm should then be replaced.

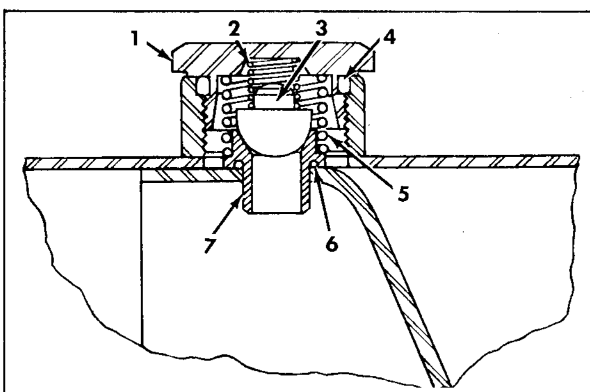
LOW AIR PRESSURE SWITCH REPLACEMENT

Removal

Exhaust air pressure from main air system. Disconnect wires from switch terminals and remove switch from air line tee fitting.

Installation

Install switch in air line tee fitting. Connect wires to switch terminals. Build up air pressure



1 Cap Nut
2 Valve Spring
3 Valve
4 Grommet
5 Valve Seat Spring
6 O-ring
7 Valve Seat

T-2251

Figure 5—Main Air Tank Check Valve

AIR SUPPLY AND CONTROL

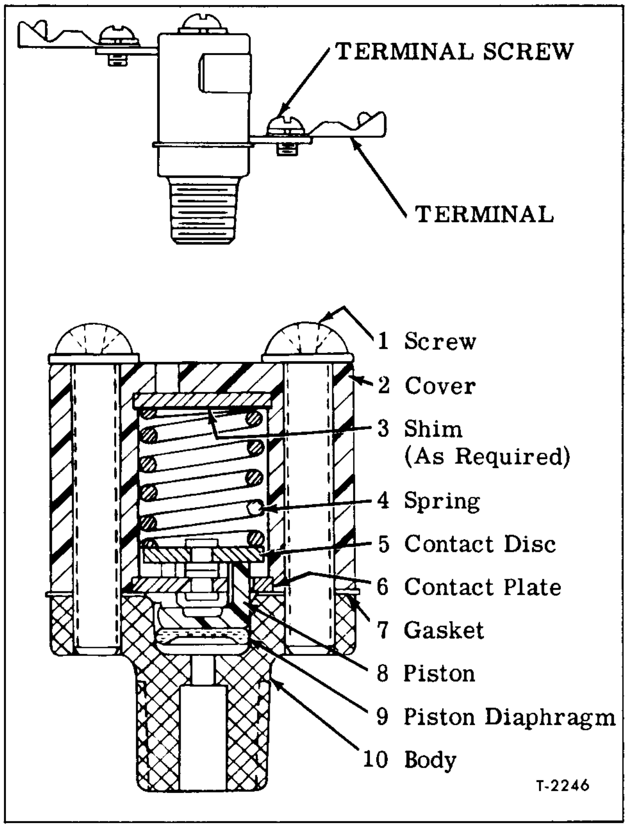


Figure 6—Low Air Pressure Switch

in system and test switch as previously directed under "Serviceability Tests."

LOW AIR PRESSURE SWITCH OVERHAUL

Key numbers in text refer to figure 6.

Disassembly

1. Remove screws (1) and cover (2) from body (10).
2. Lift out contact disc (5), spring (4), and shim(s) (3) from cover.
3. Remove gasket (7), contact plate (6), piston (8), and piston diaphragm (9) from body. Discard gasket.

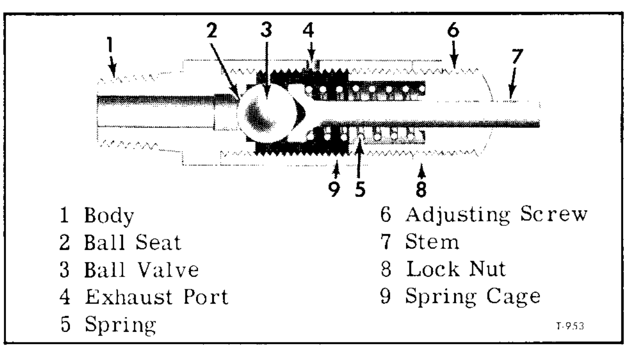


Figure 7—Safety Valve

Cleaning and Inspection

1. Clean all metal parts in cleaning solvent. Wash nylon body and piston and rubber diaphragm in soap and water solution.
2. Examine diaphragm for signs of cracking, wear, or damage. Replace diaphragm if these conditions are found.
3. Inspect contact points for signs of pitting or wear. If pitting is not too severe, contacts may be reconditioned by filing with a fine distributor point file. If they cannot be reconditioned, they should be replaced.
4. Check spring for tension. If it has lost its tension, it should be replaced. See "Specifications" at end of this section.

Assembly

Key numbers in text refer to figure 6.

1. Lubricate piston bore prior to assembly. Refer to "Specifications" at end of "SERVICE AIR BRAKE SYSTEM" section of this group for description of lubricant.
2. Place diaphragm (9) and piston (8) in body (10).
3. Set contact plate (6) in proper position to accept cover.
4. Install new gasket (7).
5. Place shims (3), spring (4), and contact disc (5) in cover.
6. Attach cover (2) to body and tighten screws firmly.
7. Test switch as previously directed under "Serviceability Tests." If pressure setting requires adjustment, add or remove shims under spring.

SAFETY VALVE

A safety valve, shown in figure 7, is installed on main air tank (fig. 4) to eliminate the possibility of air pressure building up in the system beyond a safe maximum in the event of failure of the air compressor governor.

OPERATION

When pressure in air tank is built up to exceed 145 to 155 psi, air pressure forces ball valve off seat, permitting air pressure to escape through exhaust port to atmosphere. After pressure bleeds down, spring forces ball back onto seat.

MAINTENANCE

Check safety valve periodically for leakage, using soap suds at exhaust port, with 90 pounds pressure in tank. Leakage should not exceed a 1-inch bubble in 5 seconds. Once a year, safety valve should be disassembled, cleaned with kerosene, and reset to blow off at 145 to 155 pounds pressure.

ADJUSTMENT (Fig. 5)

1. Loosen lock nut.

2. Adjust pressure by turning adjusting screw. Turn clockwise to increase pressure or counter-clockwise to decrease pressure.
3. Tighten lock nut.

AIR LINES

Metal tubing and flexible hose are used to connect the various units of the air brake system. Service instructions for both types to follow:

METAL TUBING

Metal air lines are of annealed copper tubing with three-piece compression type fitting. Flared type fittings should never be used in air brake systems. Connections should be tested for leakage at least every 5,000 miles and tightened or replaced if necessary. When replacing metal tubing, tubing must be free of burrs, copper cuttings, and dirt. Blow out with compressed air. Any of the above mentioned particles will destroy sealing seats in air control units. New tubing must be of the same size as the old tubing.

Always use a new sleeve when replacing tubing. When tightening tube connector nuts, tighten to torque listed below to assure an air-tight connection. Overtightening will cause leakage. Torque specifications for various size tubing are:

Tubing Size	Torque Inch-Pounds	Pull on End of 10 Inch Wrench
1/4 Inch	75-175	7-1/2-17-1/2 lbs.
3/8 Inch	100-200	10-20 lbs.
1/2 Inch	150-250	15-25 lbs.
5/8 Inch	150-250	15-25 lbs.
3/4 Inch	300-400	30-40 lbs.

FLEXIBLE HOSE

Flexible hose is used at each brake chamber where it is impossible to use metal tubing due to constant flexing during vehicle operation. Hose connections should be tested for leakage at least every 5,000 miles and tightened or replaced if necessary. Any hose which is chafed, worn, or kinked should be replaced.

SERVICEABILITY TESTS

1. Operating Test

If any trouble symptom such as slow brake application or slow brake release indicates restricted or clogged air line, disconnect the suspected tube or hose at both ends and blow through it to make sure the passage is clear. Inspect tubing and hose for partial restriction such as would be caused by dents or kinks. If such a condition is found, tubing or hose should be replaced.

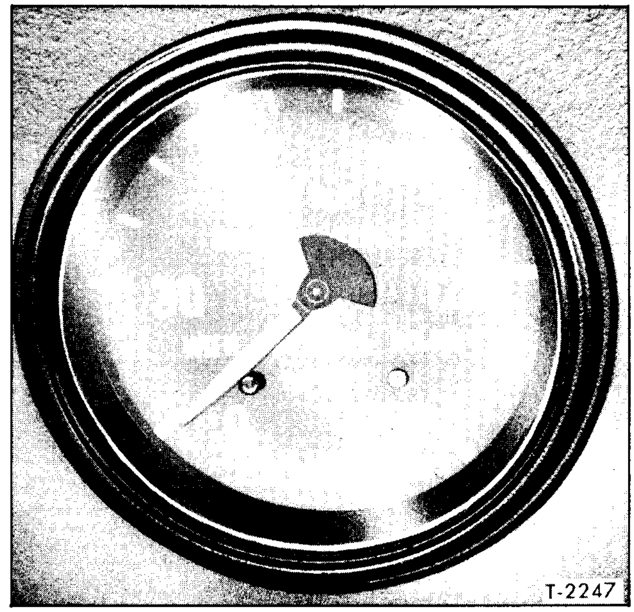


Figure 8—Air Pressure Gauge

2. Leakage Test

With air system fully charged and brakes applied, coat all tubing and hose connections with soap suds to check for leakage. No leakage is permissible. Leakage can sometimes be corrected by tightening the connection. If this fails to correct leakage, new fittings, metal tubing, or flexible hose must be installed.

AIR PRESSURE GAUGE

The air pressure gauge (fig. 8) in the instrument panel is connected into the air line from the wet tank to the emergency tank. Do not operate coach until air pressure gauge registers at least 80 pounds. Check gauge regularly with an accurate test gauge. Test should be made at 60 and 100 lbs. If reading fluctuates ± 2 pounds, replace unit.

PRESSURE REGULATING VALVE

Operation, maintenance, and repair procedures for pressure regulating valve are described in AIR SUSPENSION (SEC. 14) of this manual.

Refer to next page for "Specifications."

SPECIFICATIONS

AIR TANK CHECK VALVE

VALVE SPRING	
Free Length (Approx.)	33/64"
Compressed Length (Max.)	7/64"
Load at 7/16" Length	3 oz. ± .3 oz.
At 3/16" Length, Load Must Increase	10 oz. ± 2 oz.
VALVE SEAT SPRING	
Free Length (Approx.)	13/16"
Compressed Length (Max.)	5/16"
Load at 9/16" Length	6 lbs. ± 1/2 lb.

AIR SUPPLY LINE CHECK VALVE

VALVE SPRING	
Free Length (Min.)	9/16"
Compressed Length	1/4"
Load at 1/4" Length	2 oz. ± 1/4 oz.

EMERGENCY AIR TANK CHECK VALVE

VALVE SPRING	
Free Length (Approx.)	27/32"
Compressed Length (Max.)	7/64"
Load at 35/64" Length	2½ oz. ± 1/4 oz.
At 1/4" Length, Load Must Increase	2½ oz. ± 1/4 oz.

LOW AIR PRESSURE SWITCH

CONTACTS CLOSE AT	60 lbs. ± 6 lbs.
SPRING	
Free Length (Approx.)	5/8"
Compressed Length (Max.)	13/32"
Load at 9/16" Length	6½ lbs. ± 3/4 lb.

Service Air Brake System

BRAKE SYSTEM MAINTENANCE

Normal operation of braking system necessitates periodic tests, inspection, and adjustments to assure safe, efficient operation. Test, disassembly, inspection, repair, assembly, and adjustment procedures for each air brake control unit are described under individual headings in this section.

Compression and subsequent cooling of air causes the moisture in the air to condense. This moisture collects in air tanks and should be drained daily. It is IMPERATIVE that all air tanks and air compressor discharge muffler be drained daily to discharge any condensation which has collected.

Drain cocks are provided at bottom of air tanks for this purpose. Satisfactory draining is accomplished only by leaving the drain cocks open after compressed air has escaped and until all drainage stops. Refer to "Air Tanks" in "AIR SUPPLY AND CONTROL" section for location of air tanks and drain cocks.

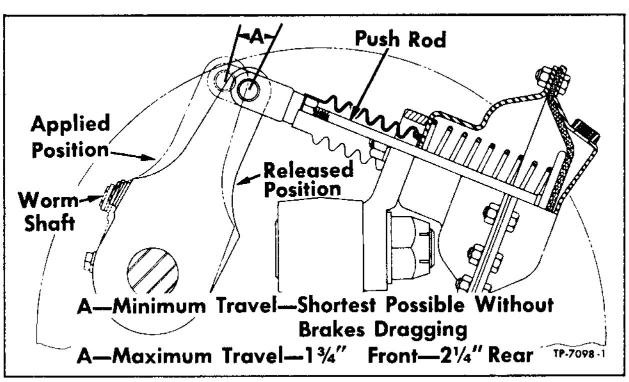


Figure 1—Brake Chamber Push Rod Travel (Typical)

The complete air system should be checked for leakage at regular intervals. Build up air pressure in system to governor cut-out point (100-107 psi), then with engine stopped and brakes released, observe rate of air pressure drop registered by the dash air pressure gauge. The rate of drop should not exceed two pounds per minute. With engine stopped and brakes fully applied, observe rate of air pressure drop registered by the dash gauge. Rate of drop should not exceed three pounds per minute. If leakage is excessive, leakage test should be made at air line connections and at all air brake control units as directed under individual headings later in this section.

Refer to "AIR COMPRESSOR AND GOVERNOR" section later in this group for information on air compressor and governor.

BRAKE ADJUSTMENTS

BRAKE SHOE ADJUSTMENT

Brake adjustment for normal lining wear is made by turning slack adjuster worm shaft (fig. 1). Brake chambers and slack adjusters installed are shown in figures 7 and 8. Brake chamber push rod travel should be checked after every 2,000 miles of operation to determine whether adjustment is necessary. While maximum travel shown in figure 2 is permissible, travel should be maintained as short as possible without brakes dragging

for braking efficiency and economy in air consumption. Brake linings should be replaced when worn to a thickness of 5/16" at center of shoe.

1. Always check wheel bearing adjustment and correct if necessary, before attempting to adjust brakes. Refer to "HUBS AND BEARINGS" (SEC. 19) of this manual.

2. With wheel jacked up, turn slack adjuster worm shaft until brake drags; then back off until wheel turns freely. NOTE: Lock sleeve must be pushed in before worm shaft can be turned. Make sure sleeve is pushed in far enough to clear hex end of worm shaft before turning shaft.

3. Be sure wheel turns freely with no brake drag when brakes are fully released. After completing adjustment, make sure lock sleeve comes out and engages hex end of worm shaft. Pry sleeve out with screwdriver if necessary. Coat lock sleeve and end of worm shaft with wheel bearing grease after completing adjustment. This keeps out dirt and water, and assures free movement of sleeve at next adjustment.

NOTE: Check brake adjustment; if brakes are properly adjusted, brake chamber push rod travel should be 5/8" to 3/4" - front and 1-1/8" to 1-1/4" - rear. Use pinch bar to check travel. DO NOT USE AIR PRESSURE.

BRAKE TREADLE ADJUSTMENT

1. Loosen lock nut on stop bolt under brake treadle and screw stop bolt in several turns.

2. Push brake treadle down to limit of its travel and adjust stop bolt to this position.

3. From full down position, raise treadle two full turns of stop bolt and tighten lock nut. This clearance protects valve parts from damage at full stop position.

4. Adjust adjusting screw (3, fig. 2) to provide 0.001" to 0.002" clearance between treadle roller and plunger with treadle held tight against adjusting screw. Tighten lock nut to secure adjustment.

BRAKE APPLICATION VALVE

DESCRIPTION

The brake application valve is mounted below coach floor in an upright position (fig. 2). Valve is attached to a mounting plate which is bolted to coach floor. The brake treadle is also mounted on the mounting plate and treadle roller contacts valve plunger. Movement of the treadle controls movement of an inlet valve and exhaust valve which in turn control air pressure being delivered to or released from the brake chambers. To fully apply brakes, the treadle must be fully depressed, whereas, when treadle is only partially depressed, correspondingly less braking force is developed. In other words, the farther the driver depresses treadle, the greater the air pressure delivered to the brake chambers and the more effective brake application. Brake valve is set to graduate between 5 and 75 psi. First three degrees of brake treadle travel permits valve to deliver 5 psi, and the next 17 degrees of travel is the graduating range (5 to 75 psi). With any treadle movement beyond the first 20 degrees of travel, valve will deliver full reservoir pressure.

OPERATION

1. Application

Foot pressure on brake treadle compresses graduating spring and forces piston down. This brings exhaust valve seat at lower end of piston to upper face of inlet-exhaust valve, closing exhaust passage. Continued downward movement of piston forces inlet valve off inlet valve seat. Air pressure from air tank then flows through inlet valve and outlet ports to brake chambers, applying service brakes.

2. Holding

The compensating passage in body permits air pressure being delivered to brakes to enter cavity below piston. When air pressure below piston balances treadle pressure, piston lifts far enough to close inlet valve, cutting off further supply of air pressure to brake chambers. The exhaust valve remains closed preventing any escape of air pressure through exhaust port. Increased pressure on brake treadle forces piston down and causes a graduated increase of air pressure at brake chambers.

3. Partial Release

As pressure on brake treadle is reduced, spring and foot pressure above piston becomes less than air and spring pressure below piston, causing piston to move upward. As piston moves up, inlet valve closes and exhaust valve opens permitting air pressure below piston to escape through hollow center of piston and out exhaust port until pressure on each side of piston again balances.

4. Release

As foot pressure on brake treadle is removed, the exhaust valve opens and remains open, exhausting all air pressure from brake chambers through exhaust port and fully releasing service brakes.

APPLICATION VALVE SERVICEABILITY TESTS

1. Operating Tests

Check delivery pressure of the valve, using an accurate test gauge connected into one of the air lines leading to the brake chambers. With brake treadle fully depressed, test gauge should show the same pressure as registered on dash air gauge (within 5 pounds).

SERVICE AIR BRAKE SYSTEM

1 Treadle
2 Treadle Pin
3 Adjusting Screw
4 Mounting Plate
5 Body
6 Inlet Nut
7 Inlet Valve Seat
8 O-ring
9 Inlet and Exhaust Valve Assembly
10 O-ring
11 Piston Return Spring
12 O-ring
13 Piston
14 Filter Screen
15 Graduating Spring
16 Spring Seat
17 Adapter Plate
18 Boot
19 Plunger
20 Roller
21 Roller Pin

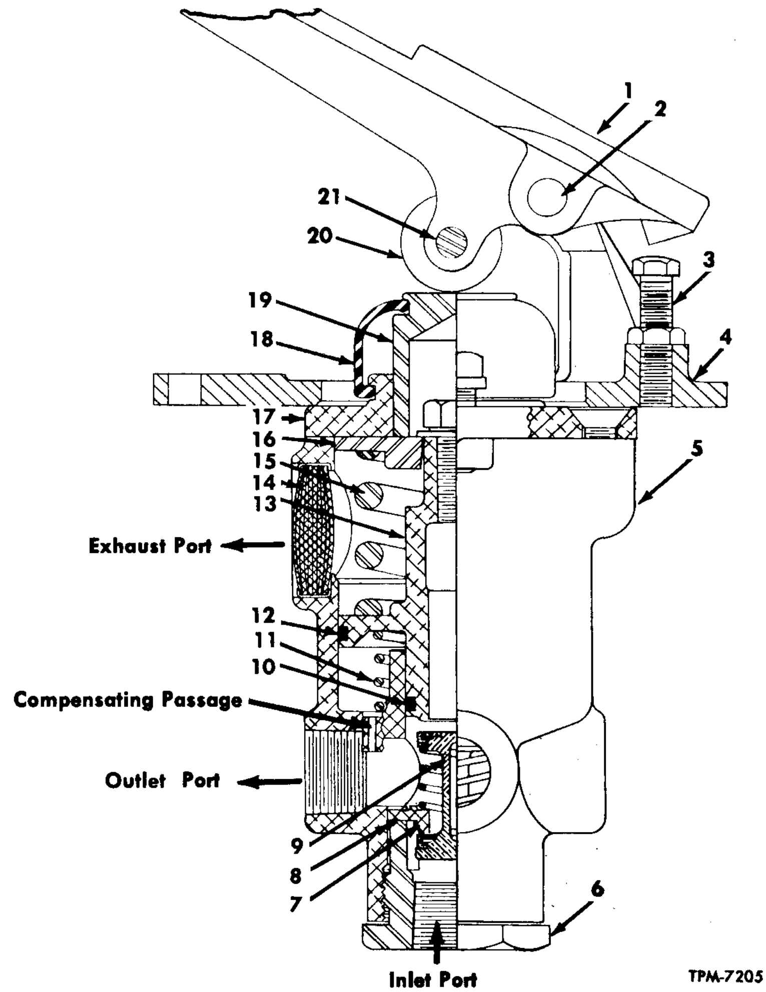


Figure 2—Brake Application Valve

Depress brake treadle to several positions between fully released and fully applied and note that pressure registered by the test gauge varies in accordance with degree brake treadle is depressed.

2. Leakage Tests

a. With brake treadle fully released, coat exhaust port with soap suds to check for leakage. Leakage in excess of a 1-inch bubble in 1 second is not permissible. Leakage evidenced by this test is probably caused by worn or deteriorated inlet valve.

b. With treadle fully depressed, coat exhaust port with soap suds to check for leakage. Leakage in excess of a 1-inch bubble in 1 second is not permissible. Leakage evidenced by this test may be due to a leaking exhaust valve or leaking piston O-ring seals.

APPLICATION VALVE REPLACEMENT

NOTE: Brake application valve can be removed from coach separately or with the brake treadle. Access to application valve may be gained through safety equipment compartment door at left front of coach.

Removal of Brake Application Valve

1. Block wheels or hold vehicle by means other than air brakes.
2. Open drain cocks and exhaust air from air brake system.
3. Disconnect wires from stop light switch and remove switch.
4. Remove two cap screws attaching valve to brake treadle mounting plate.
5. Disconnect air lines from valve and remove valve.

Removal of Application Valve and Brake Treadle

1. Perform steps 1, 2, 3, and 5 of previous removal procedure.

2. Remove four nuts attaching brake treadle mounting plate to floorboard.

3. Remove brake treadle and application valve through floorboard in driver's compartment.

Installation of Application Valve

1. Attach valve to brake treadle mounting plate with two cap screws.

2. Connect air lines to valve ports. When installing connector fitting in valve, use sealing compound on fitting threads. KEEP SEALING COMPOUND OFF FIRST TWO THREADS OF FITTINGS.

3. Install stop light switch and connect wires to switch.

4. Build up air pressure in system and test application valve as previously directed under "Serviceability Tests."

Installation of Application Valve and Brake Treadle

1. Position brake treadle mounting plate with application valve attached. Attach to floorboard with four bolts, washers, and nuts. Tighten securely.

2. Perform steps 2, 3, and 4 of previous installation procedure.

APPLICATION VALVE OVERHAUL

Key numbers in text refer to figure 2.

Disassembly

1. Clean all dirt from outside of valve.

2. Remove two cap screws and lock washers attaching mounting plate (4) to adapter plate (17). Separate mounting plate and adapter plate.

3. Remove cotter pin, tap out treadle pin (2), and remove treadle (1) from mounting plate. Remove roller (20) by removing cotter pin and by tapping out roller pin with pin punch and small hammer. Remove roller. Both treadle pin and roller pin are held in place by cotter pins. Remove adjusting screw (3) and lock nut.

4. Remove boot (18) and plunger (19) from adapter plate (17). Remove three screws attaching adapter plate to body (5). Lift off adapter plate.

5. Lift piston and spring assembly from body. Remove O-rings (10 and 12) from piston and discard. Remove cap screw, lock washer, and flat washer from end of piston (13). Remove spring seat (16) and graduating spring (15) from piston.

6. Remove piston return spring (11) from body.

7. Remove inlet nut (6) and O-ring (8) from body. Discard O-ring. Remove inlet valve seat (7) and inlet and exhaust valve assembly (9) from body.

8. Remove self-tapping screw from body and take out filter screen (14). Remove pipe plugs.

Inspection

Replace the following parts with new parts when overhauling application valve: Boot, O-rings, and inlet and exhaust valve assembly. Wash all other parts in cleaning solvent, dry thoroughly and inspect as follows:

1. Treadle, Roller, and Pins. Check fit of treadle pin in treadle and mounting plate. Pin must be a neat, free fit. If mounting plate holes are worn excessively, the plate should be replaced. Check fit of roller on roller pin. There should be a free rolling fit between roller and pin. Replace badly worn or damaged parts with new parts.

2. Adapter and Plunger. Inspect adapter plate for cracks or signs of damage. Check fit of plunger in adapter plate. Replace parts if necessary.

3. Piston. Inspect exhaust seat of piston. Remove slightly worn spots by lapping on a piece of crocus cloth on a flat surface. Inspect outside surfaces of piston which contact bores in body of valve for scratches, nicks, or out-of-round condition. Replace piston if badly worn or damaged.

4. Piston Return Spring, Graduating Spring, and Seat. Inspect piston return spring, graduating spring, and spring seat. Damaged or broken spring or seat should be replaced with new part.

5. Inlet and Exhaust Valve Assembly. Inspect seating surface of inlet and exhaust valve for roughness or signs of wear that might cause leakage. Replace assembly if badly worn or damaged.

6. Body. Inspect bores of body for scratches, scores, or excessive wear. Remove any obstruction from compensating passage. Replace body if necessary.

Assembly (Fig. 2)

1. Install cleaned or new filter screen (14) in exhaust port of valve body (5). Install self-tapping screw to lock filter screen in place.

2. Place graduating spring (15) and spring seat (16) over piston. Install flat washer, lock washer, and cap screw at top of piston. Tighten cap screw firmly against spring retainer. Install new O-rings (10 and 12) on piston (13). Coat O-rings, piston, and piston bore with lubricant. Refer to "Specifications" at end of this section for description of lubricant. Install return spring (11) and piston assembly in body.

3. Install adapter plate (17) on body. Secure in place with three screws.

4. Install plunger (19) and boot (18) in adapter plate.

5. Install inlet and exhaust valve assembly (9) with seat inlet valve in bottom of body. Place new O-ring (8) against inlet valve seat and install inlet nut (6).

6. Place roller (20) in position in treadle (1) and tap roller pin (21) in place. Install new cotter pin. Install adjusting screw (3) and lock nut on mounting plate.

SERVICE AIR BRAKE SYSTEM

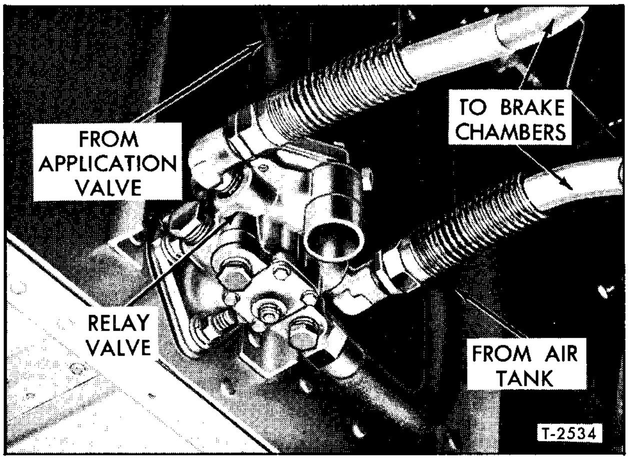


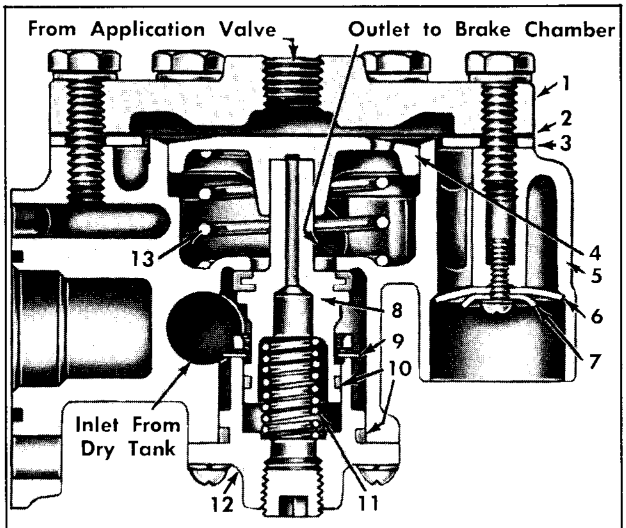
Figure 3—Rear Brake Relay Valve Installed

7. Place treadle assembly in position on mounting plate and tap treadle pin (2) in place. Install new cotter pin.

8. Place treadle mounting plate on valve adapter plate, and attach with two cap screws and two lock washers.

STOP LIGHT SWITCH

Operation, maintenance and repair procedures are fully described in "LIGHTING SYSTEM" in ELECTRICAL (SEC. 7) of this manual. Stop light switch is an air-operated unit actuated by, and mounted to, brake application valve.



1 Valve Cover	8 Inlet Valve
2 Valve Diaphragm	9 Retaining Ring
3 Diaphragm Ring	10 O-ring
4 Diaphragm Guide	11 Valve Spring
5 Body	12 Guide Cap
6 Exhaust Diaphragm	13 Spring
7 Diaphragm Washer	TPM-8701

Figure 4—Rear Brake Relay Valve

REAR BRAKE RELAY VALVE

Relay valve is mounted on bulkhead above rear axle (fig. 3). Rear brake application and release is made through the relay valve. The supply line from air tank connects to a cavity in lower part of the valve, providing a source of high pressure air close to rear brake chambers at all times. The relay valve and brake application valve are interconnected by a smaller air line which delivers air pressure to top of the relay valve diaphragm to actuate the valve. In addition to providing more rapid application of rear brakes, relay valve also fulfills the function of a quick release valve, permitting rapid release of air pressure from rear brake chambers.

RELAY VALVE OPERATION (Fig. 4)

Operation of the relay valve is controlled by air pressure delivered to it by the brake application valve. Air pressure from brake application valve enters a cavity above the rubberized diaphragm. Since this cavity is comparatively small and therefore subject to quick changes in air pressure, action of the valve in changing its delivered pressures is very rapid.

1. Applying

As compressed air from the application valve enters cavity at top, air pressure pushes down diaphragm sealing off exhaust cavity. Further movement of diaphragm center forces down diaphragm guide and inlet valve. As inlet valve is forced off seat, air from dry air tank flows through valve into cavity below diaphragm and on out to brake chambers.

2. Holding

As soon as air pressure above the diaphragm stops increasing, pressure below the diaphragm balances by means of the by-pass port in valve cover. This balance of pressures on each side of diaphragm removes pressure from diaphragm guide and inlet valve. Valve spring then closes inlet valve. Air pressure above the diaphragm maintains seal between outer edge of diaphragm and rim of exhaust cavity. The valve is now in holding position. Brake chamber pressure is the same as application valve pressure. An increase in pressure at application valve will immediately result in the same pressure increase in brake chambers.

3. Releasing

When the application valve pressure above diaphragm is reduced, brake chamber pressure

(below diaphragm) forces diaphragm upward. As diaphragm uncovers rim of exhaust cavity, air is exhausted until pressures again balance. If all pressure is removed from application valve treadle, the relay valve will release all air from brake chambers, fully releasing brakes.

RELAY VALVE SERVICEABILITY TESTS

1. Operating Test

With air brake system fully charged, apply brakes and make sure rear wheel brakes apply promptly. Release brakes and make sure air pressure is quickly exhausted from exhaust port of the relay valve.

2. Leakage Tests

a. With brakes released, cover exhaust port with soap suds. Leakage in excess of 1-inch bubble in one second is not permissible. Leakage is caused by inlet valve not seating properly.

b. With brakes applied, cover exhaust port with soap suds. Leakage in excess of a 1-inch bubble in one second is not permissible. Leakage is caused by defective diaphragm or seat.

c. If leakage is caused by diaphragm, both diaphragm and diaphragm seat should be wiped clean with gasoline. If leakage is caused by inlet valve, valve and seat must be cleaned, or replaced with new parts.

RELAY VALVE REPLACEMENT

Removal

1. Exhaust air pressure from system.
2. Disconnect air lines from valve.
3. Remove mounting bolts; then remove valve assembly from vehicle.

Installation

1. Mount valve on bulkhead and tighten mounting bolts firmly.
2. Connect air lines to valve.
3. Build up air pressure in system; then test valve as previously directed under "Serviceability Tests."

RELAY VALVE OVERHAUL

Disassembly (Fig. 4)

1. Mark valve cover (1), diaphragm ring (3), and valve body (5), so parts can be reassembled in same position.
2. Remove six cap screws and lock washers attaching valve cover (1) to valve body (5).
3. Remove cover (1), diaphragm (2), diaphragm ring (3), diaphragm guide spring (13), and diaphragm guide (4) from valve body (5).
4. Remove four screws and lock washers attaching guide cap (12) to bottom of valve body (5).
5. Remove guide cap (12) and inlet valve assembly (8).
6. Remove retaining ring (9) and separate inlet valve, valve spring (11), and guide cap (12). Remove and discard O-rings (10).
7. Remove screw and lock washer holding exhaust diaphragm (6) in place. Remove diaphragm washer (7) and exhaust diaphragm (6).

Inspection

1. Thoroughly clean all parts in a suitable cleaning solvent.
2. Examine diaphragms for cracking, stretching, or deterioration. Replace if not in good condition.
3. Inspect diaphragm seat at top of valve body. Seat must be smooth and free from scratches or corrosion. If only slightly scratched or corroded, seat may be repaired by lapping on a flat surface covered with fine aluminum oxide abrasive cloth.
4. Examine inlet valve and inlet valve seat. Rubber seating surface on inlet valve is bonded in place. If valve or seat are scratched or worn, replace with new parts.
5. Inspect spring for free length, compressed length, distortion, or collapsed coils. (See "Specifications" at end of this section.)
6. Diaphragm guide bore in valve body, and inlet valve bore in guide cap should be smooth. If damaged, replace parts.

Relay Valve Assembly (Fig. 4)

1. Place new O-ring (10) on guide cap (12) and on inlet valve (8).
2. Apply a thin coat of lubricant inside guide cap, and on body bores in contact with cap and with diaphragm guide (4). Refer to "Specifications" at end of this section for description of lubricant.
3. Insert spring (11) and O-ring end of inlet valve (8) in guide cap (12) bore. Force inlet valve down into guide cap.
4. Place retaining ring (9) in cap groove and snap around narrow neck of inlet valve (8).
5. Insert inlet valve and cap assembly through bottom of relay valve body (5).
6. Attach cap to body with four screws and lock washers. Tighten firmly.
7. Position diaphragm guide spring (13) in valve body; then place diaphragm guide (4) over stem of inlet valve (8).
8. Position diaphragm ring (3) on body (5), aligning match marks previously installed.
9. Place diaphragm (2) on ring (3) and align by-pass holes.
10. Install cover (1) aligning match marks. Parts should be aligned now, without obstructing by-pass port.
11. Install six cap screws and lock washers and tighten firmly and evenly.

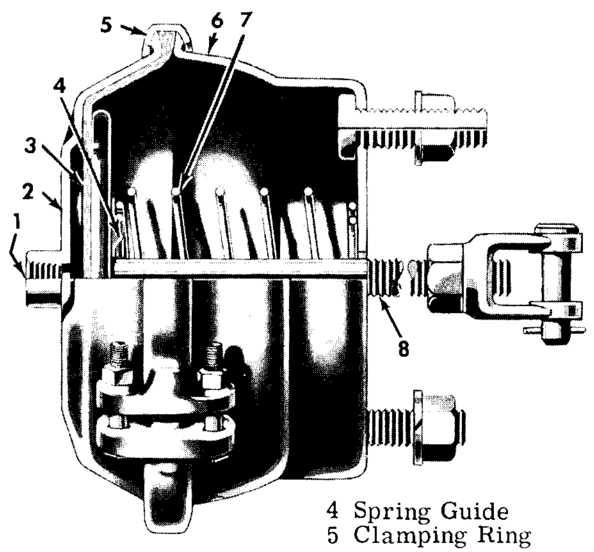


Figure 5—Front Brake Chamber

12. Insert exhaust diaphragm (6) and diaphragm washer (7) (cupped side away from diaphragm) in exhaust port. Install screw and lock washer and tighten firmly.

BRAKE CHAMBERS

Each front brake chamber is mounted at wheel as shown in figure 7. Rear brake actuators are mounted at rear end of rear suspension support (fig. 8). Front brake chanbers are connected to air system through the application valve. Rear brake actuator service ports are connected through brake relay valve.

The purpose of brake chambers is to convert the energy of compressed air into the mechanical force and motion necessary to operate the mechanical brake assembly at each wheel. Brake chambers are linked, through slack adjusters, to brake operating cams. As air pressure extends push rod, slack adjuster acts as a lever and turns cam, expanding brake shoes in drum.

> NOTE: The following procedures apply only to the front brake chambers. Complete operation, maintenance and repair procedures for rear brake chambers will be found in "DD3 PARKING AND EMERGENCY AIR BRAKE SYSTEM" section.

OPERATION (Fig. 5)

As air pressure enters the brake chamber behind the diaphragm, the diaphragm forces the push rod outward, thus applying force to slack adjuster which rotates camshaft, applying brakes. When air pressure is released from the brake chamber, the brake shoe springs and the push rod springs return the brake shoes, camshaft, slack adjuster, push rod, and diaphragm to released position. Due to the extreme sensitivity of the diaphragm, the push rod responds to the slightest variation of air pressure delivered to the brake chamber. This permits the driver to apply or release brakes as rapidly or as gradually as various road or operating conditions warrant.

FRONT BRAKE CHAMBER
SERVICEABILITY TESTS

<u>1. Operating Test</u>

Apply brakes. Brake chamber push rods should move out promptly without binding. Release brakes. Rods should return to released position promptly without binding.

<u>2. Leakage Tests</u>

a. Fully apply brakes. Coat edges of the clamping ring with soap suds to check for leakage. No leakage is permissible. If leakage is found, tighten clamp ring bolts evenly but only sufficiently to prevent leakage, otherwise the diaphragm will be distorted resulting in premature failure.

b. Fully apply brakes. Check for leakage through the diaphragm by applying soap suds to drain hole and to push rod opening in non-pressure plate. No leakage is permissible. If soap bubbles indicate a leak, replace diaphragm.

FRONT CHAMBER
REPLACEMENT

<u>Removal</u>

1. Disconnect hose from brake chamber as follows: Hold hose union nut with a wrench while turning connector out of fitting in brake chamber. If new brake chamber is to be installed, remove connector fitting for installation on replacement unit.

2. Remove cotter pin and clevis pin; then remove push rod yoke from slack adjuster.

3. Remove nuts and lock washers from two brake chamber mounting studs; then remove brake chamber assembly from bracket.

<u>Installation</u>

1. Position brake chamber on bracket, with mounting studs through holes in bracket. Install lock washer and nut on each stud and tighten firmly.

2. Install connector fitting in brake chamber.

3. Connect hose as follows: Thread connector into fitting and tighten firmly while holding hose union nut with a wrench.

4. Connect brake chamber push rod yoke to slack adjuster. Adjust brakes as previously directed under "Brake Adjustments." Apply brakes and make sure push rods are correct length. Angle formed by push rod and slack adjuster should form an angle of more than 90 degrees, and should still be slightly greater than 90 degrees with brakes applied. In other words, the slack adjuster should not go "over center" when brakes are applied. If necessary, adjust push rod length by turning yoke onto or off push rod. Push rod must not extend through yoke far enough to interfere with the slack adjuster. Test brake chamber as previously directed under "Serviceability Tests."

FRONT BRAKE CHAMBER OVERHAUL

Disassembly (Fig. 5)

1. Before disassembling brake chamber, mark non-pressure plate, pressure plate, and clamp ring. Parts may then be reassembled in same relative position. This will eliminate possibility of installation interference when brake chamber is reinstalled.

2. Remove yoke and lock nut from push rod. Remove nuts from two clamp ring bolts and remove bolts. Use caution when separating plates because of tension on return spring. Spread clamp ring and remove from plates; then remove pressure plate and diaphragm.

3. Remove push rod, spring guide, and spring from non-pressure plate.

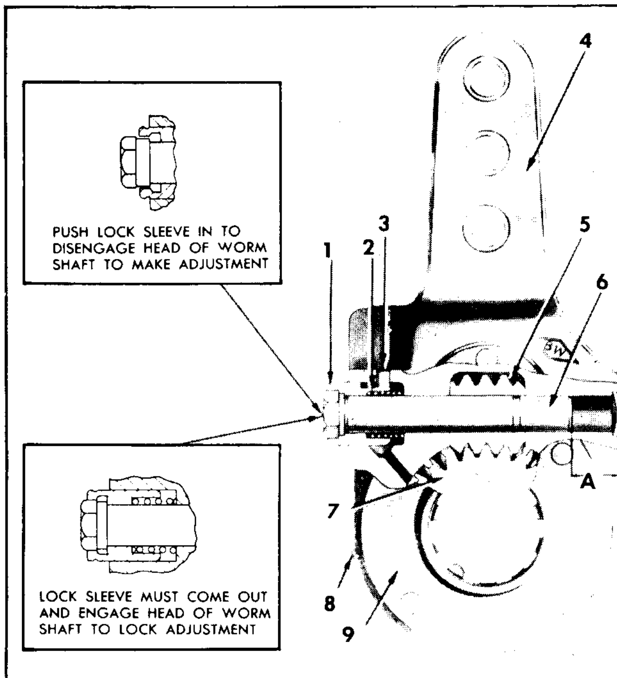
Cleaning and Inspection

1. Clean all metal parts thoroughly, using a suitable cleaning solvent.

2. Examine diaphragm at brake reline. Replace with new part if any signs of damage or deterioration are evident.

3. Examine push rod and spring. Replace with new parts if weak or broken. Replacement spring should have the same tension as spring in opposite brake chamber. Mismatched springs will result in unbalanced braking. See "Specifications" at end of this section for spring dimensions and tensions.

4. Inspect pressure plate and non-pressure plate. Clamping flanges on plates should not be bent or otherwise damaged. Replace damaged parts.



1 Lock Sleeve
2 Spring
3 Dowel
4 Lever
5 Worm
6 Worm Shaft
7 Gear
8 Lubrication Fitting
9 Cover Plate

A—See Text

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Figure 6—Slack Aduster (Typical)

Assembly (Fig. 5)

1. Install spring guide, spring, and non-pressure plate on push-rod.

2. Place clamp ring over flange of non-pressure plate and align marks made prior to disassembly.

3. Position diaphragm in pressure plate. Position plate and diaphragm against the non-pressure plate; then place brake chamber assembly in a vise. Carefully close vise until clamp ring can be worked over flange of pressure plate. Align marks previously inscribed.

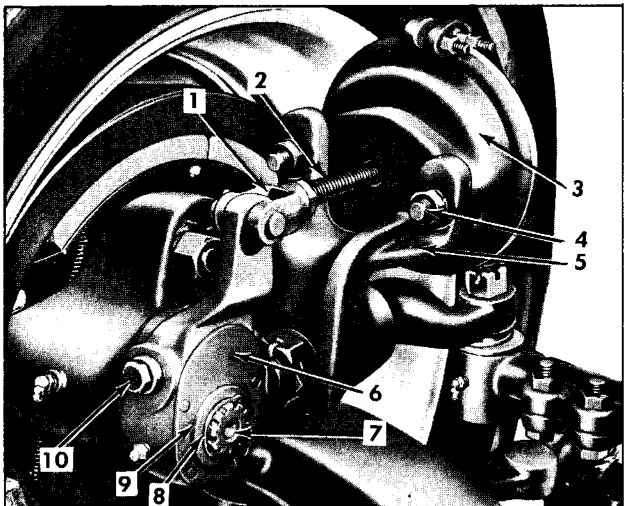
4. Use vise-grip pliers or C-clamp on side of lugs on clamp ring. Draw clamp ring together and install one bolt and nut. Remove tool and install the other bolt and nut. Tighten just enough to form an air-tight seal. Remove brake chamber from vise.

5. Install lock nut and yoke on push rod.

SLACK ADJUSTERS

Slack adjusters function as adjustable levers and provide a quick and easy method for adjusting

SERVICE AIR BRAKE SYSTEM



1 Push Rod Yoke	7 Camshaft
2 Push Rod	8 Snap Ring
3 Brake Chamber	9 Washer
4 Brake Chamber Mounting Stud	10 Slack Adjuster Worm Shaft
5 Brake Chamber Bracket	
6 Slack Adjuster	

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Figure 7—Front Brake Chamber, Bracket, and Slack Adjuster Installed on Axle

brakes to compensate for normal lining wear. Positive locking type slack adjusters are used at front and rear brakes. Construction of both front and rear slack adjusters is shown in figure 6. Front and rear slack adjuster installations are shown in figures 7 and 8.

Slack adjuster consists basically of a hardened steel gear, which is splined to the brake camshaft, a brake lever (body), and hardened steel worm which is mounted in the lever above the gear, and meshes with teeth in gear. Turning the worm shaft causes rotation of camshaft in relation to brake lever. During brake operation, the entire slack adjuster rotates bodily with the camshaft. As brake chamber push rod reaches its maximum travel due to normal lining wear, turning worm shaft rotates lever back to original setting.

SLACK ADJUSTER SERVICEABILITY TEST

Adjust brakes as previously directed under "Brake Adjustment" in this section; then carefully measure brake chamber push rod travel as brakes are applied. Make several full brake applications and again measure push rod travel. Push rod travel should be the same as it was immediately after adjustment. If push rod travel increases, or if difficulty is experienced in keeping brakes adjusted in service, slack adjuster must be overhauled or replaced.

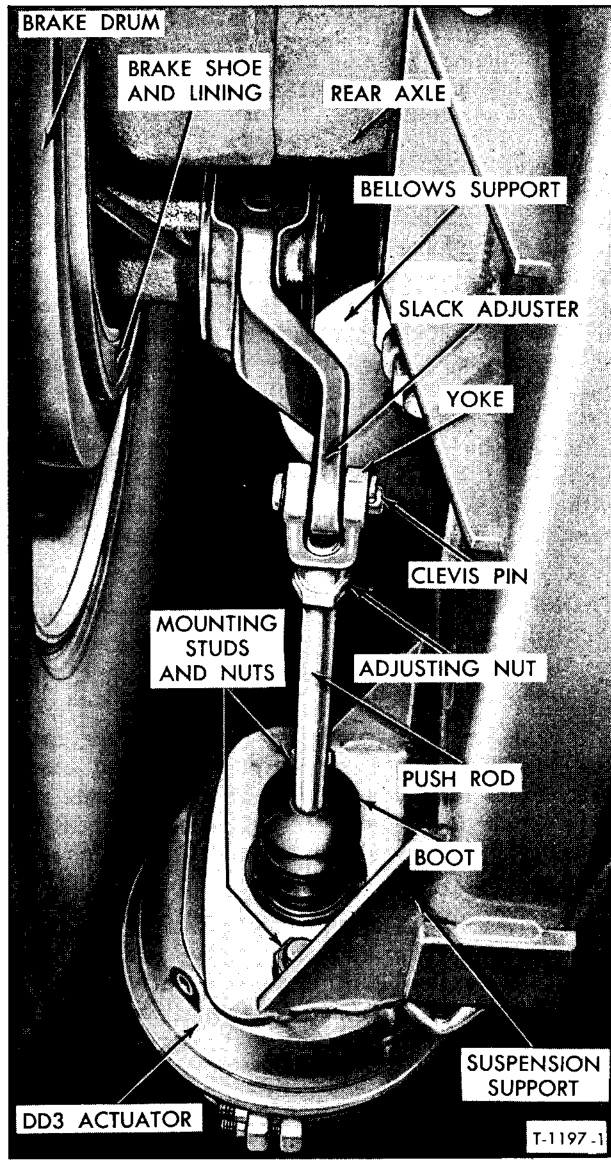


Figure 8—DD3 Rear Brake Actuator and Slack Adjuster Installed

SLACK ADJUSTER REPLACEMENT

Removal (Fig. 7 or 8)

1. Remove clevis pin attaching slack adjuster to brake chamber push rod.
2. Remove snap ring and washer (front) or bolt and washers (rear) securing slack adjuster on camshaft. Slide slack adjuster off end of shaft.

Installation (Fig. 7 or 8)

1. If a new slack adjuster is being installed, make sure it is the same size and type as the one removed. Slide slack adjuster onto camshaft and attach with bolt and washers (rear) or with snap ring and washer (front).

2. Connect brake chamber push rod to slack adjuster, using clevis pin and new cotter pin.

3. Lubricate slack adjuster as directed in LUBRICATION (SEC. 13) of this manual.

4. Adjust brakes as previously directed under "Brake Adjustments."

SLACK ADJUSTER OVERHAUL

Disassembly (Fig. 6)

1. Remove dirt and grease from outside of unit by washing in suitable cleaning solvent.

2. Cut off riveted ends of rivets attaching cover plates to body. Drive out rivets and remove cover plates.

3. Remove welch plug from end of worm shaft bore. Insert a flat end punch into the worm shaft bore and drive worm shaft out of body and worm.

4. Remove lock sleeve and spring from worm shaft. Remove gear and worm from slack adjuster body. Remove lubrication fitting.

Inspection and Repair

1. Wash parts in cleaning solvent and wipe or blow parts dry.

2. Inspect worm and gear and replace with new parts if chipped or broken teeth are evident.

3. Inspect worm shaft for wear. Make sure corners on hex end are not rounded.

4. Inspect bushing in lever arm. If worn, out-of-round, or otherwise damaged, it must be replaced. To replace bushing, press old bushing out and press new bushing into place. Bushing must be reamed after installation to 0.501"-0.503".

5. Examine lock sleeve for cracks or other damage. Replace if necessary.

6. Examine lever (body) for cracks or distortion. If lever is damaged in any way, a new body and bushing assembly must be used.

Assembly (Fig. 6)

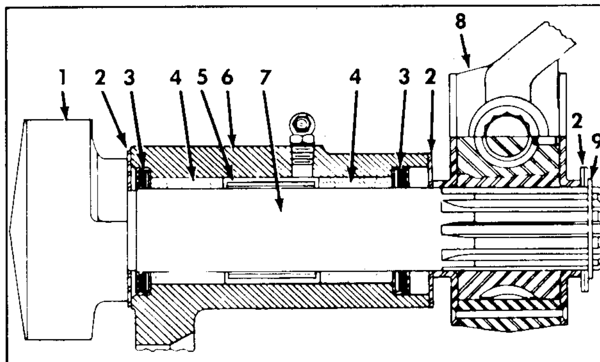
1. Place worm and gear assembly in position in body.

2. Place lock sleeve over worm shaft, with socket-like end of sleeve at hex end of shaft. Place lock spring in recess formed by sleeve and shaft.

3. Enter small end of worm shaft through hole in body and worm. Press worm shaft into worm and body, making sure the groove in lock sleeve is aligned with pin in body. Press shaft in until distance from small end of shaft to edge of body (A, fig. 6) is 9/16". Install welch plug in worm shaft bore.

4. Position cover plates on body and attach with new rivets. Covers must be flat and in good contact with body after riveting.

5. Install lubrication fitting in body. Connect a grease gun to fitting and force grease into slack adjuster until it is completely filled. Refer to LUBRICATION (SEC. 13) of this manual for type of lubricant.



1 Cam (Integral with Shaft)
2 Spacing Washers
3 Oil Seal
4 Bushing
5 Bushing Spacer
6 Brake Spider
7 Camshaft
8 Slack Adjuster
9 Snap Ring TPM-6912

Figure 9—Front Brake Camshaft and Slack Adjuster Mounting

FRONT BRAKE SHOES, LININGS, AND CAMSHAFTS

SHOES AND LININGS

Brakes at each front wheel have two shoes which pivot on anchor pins at one end and are expanded at the other end during brake application by constant lift S-type cams. Brake shoe return springs hold shoe ends firmly against cam. Two-piece block type lining is bolted to each shoe. Holes through lining and upper shoe at cam end are provided to facilitate removing and installing return springs.

Cam end of each shoe is equipped with a roller which acts as contact between shoe and cam. Roller shaft is integral with roller and rides in a groove at toe end of shoe web. Shoe return springs hold roller securely between cam and toe of shoe.

CAMSHAFTS

Front brake camshafts are mounted in two bushings in brake spider (fig. 9). Lubrication fitting in spider provides method for lubricating bushings. Lubricant is retained by seals which are pressed into spider.

ANCHOR PINS

Anchor pin end of each shoe fits between brackets at brake spider, and is retained by straight type anchor pin (fig. 10). Both anchor pins are held in place by a lock plate which engages notches in end of each pin and is attached to brake spider by a cap screw. Anchor pin ends of shoes are equipped with replaceable bushings.

SERVICE AIR BRAKE SYSTEM

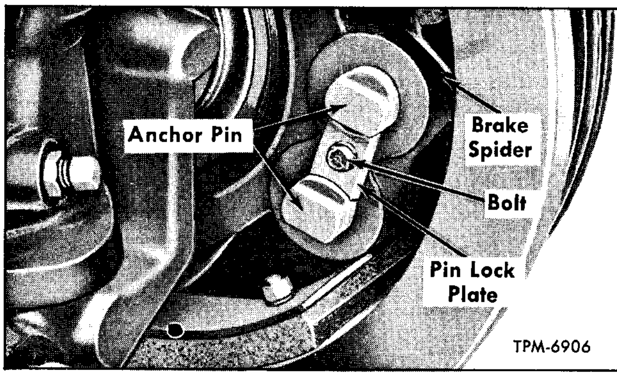


Figure 10—Front Brake Shoe Anchor Pins Installed (Typical)

FRONT BRAKE SHOE AND CAMSHAFT REMOVAL

1. Jack up front axle and remove wheel and brake drum. Remove hub as directed in "HUBS AND BEARINGS" (SEC. 19) of this manual.

2. Drive plugs out of lining at cam end of upper shoe, using a punch through holes in shoe. Using a hooked tool through holes in lining and shoe, unhook springs from pin in upper shoe. Remove springs from pin in lower shoe. Tag or mark shoes so they may be reinstalled in their original position.

3. Remove anchor pin lock plate. Drive anchor pins out of brake spider and shoes; then remove brake shoes.

4. To remove camshaft (fig. 9), disconnect brake chamber push rod yoke from slack adjuster. Remove snap ring and washer securing slack adjuster on camshaft and pull slack adjuster off end of shaft. Pull camshaft out of brake spider, stripping spacing washers off shaft as shaft is removed.

INSPECTION

1. Wash all parts except shoe and lining assemblies in cleaning solvent. Check anchor pins and brake shoe bushings for wear in accordance with dimensions listed in "Specifications" at end of this group. Replace with new parts any that are badly worn. If brake shoe bushings are replaced, burnish after installation.

2. Examine camshaft bushings, spacer, and seals. If there is any indication of wear or damage, remove old parts and replace with new. Remove seals; then remove bushings by inserting tool through spider and tapping on inside end of each bushing. When installing new bushings, carefully drive into place with a suitable driver. Install spacer between bushings. New seals should be soaked in oil until soft and pliable before installing. Seals should be installed with tapered edge out to permit installation of camshaft without damage.

3. Check fit of roller hubs in shoes. If excessive looseness is evident, remove rollers and check for wear. Replace worn parts. Lubricate roller hubs before installing.

4. Check tension of brake shoe return springs. Replace if weak or broken.

5. Check thickness of brake lining at center of shoe. If worn down to 5/16" thickness, lining must be replaced. When replacing linings, lining with return spring access holes must be installed at cam end of upper shoe. Linings must be securely bolted to shoes. New lock washers should be used and nuts tightened to 18-23 foot-pounds torque. A 0.006" feeler must not enter between shoe and lining at any point. Drive lining plugs into bolt holes in lining when installation is completed. Make sure roller in shoe is standard size when new linings are installed.

6. Examine camshaft for cracks, distortion, or wear at the bushing surfaces. Replace if worn or damaged.

7. If brake drums have been machined oversize, refer to instructions under "Brake Drums" later in this section.

FRONT CAMSHAFT AND BRAKE SHOE INSTALLATION

1. Work lubricant into camshaft bushings. Refer to LUBRICATION (SEC. 13) for type lubricant.
2. Install large spacing washer on camshaft and insert camshaft through bushings in spider (fig. 9), being careful not to damage oil seals.
3. Install brake shoes at brake spider in same position from which they were removed. Insert anchor pins through brake spider and shoes. Turn anchor pins so notches in inner end face each other. Install anchor pin lock plate and secure with cap screw and lock washer (fig. 10).
4. Hook one end of brake shoe return springs on pin in lower brake shoe. Stretch springs and hook onto pin in upper shoe, using hooked tool through holes in lining and shoe. Drive lining plugs into holes after hooking springs.
5. Place spacing washer and spacer over inner end of camshaft (fig. 9), install slack adjuster on camshaft, and secure with washers and snap ring. Connect brake chamber push rod yoke to slack adjuster, using clevis pin and cotter pin. Back off slack adjuster worm shaft until shoe rollers rest on lowest points on cam.

6. Install hub, drum, and wheel, and adjust bearings as directed in "HUBS AND BEARINGS" (SEC. 19) of this manual.
7. Adjust brakes as previously directed under "Brake Adjustment" in this section.
8. Lubricate camshaft bearings as directed in LUBRICATION (SEC. 13) of this manual.

REAR BRAKE SHOES, LININGS, AND CAMSHAFTS

SHOES AND LININGS

Brakes at each rear wheel have two shoes which pivot on anchor pins at one end and are expanded at the other end during brake application by constant lift S-type cams. Brake shoe return springs hold shoe ends firmly against cam. Two-piece block type lining is bolted to each shoe. Hole through lining and upper shoe at cam end are provided to facilitate removing and installing springs. Cam end of each shoe is equipped with a roller which forms the contact between shoe and cam.

ANCHOR PINS

Heel of each brake shoe is attached to anchor pins which are installed in brake spider as shown in figure 11. Shoes are retained on anchor pins by a strap, two tapered dowels, two lock washers, and two nuts. Spacing washers are used as required to provide proper fit of shoe end between spider and strap.

CAMSHAFTS

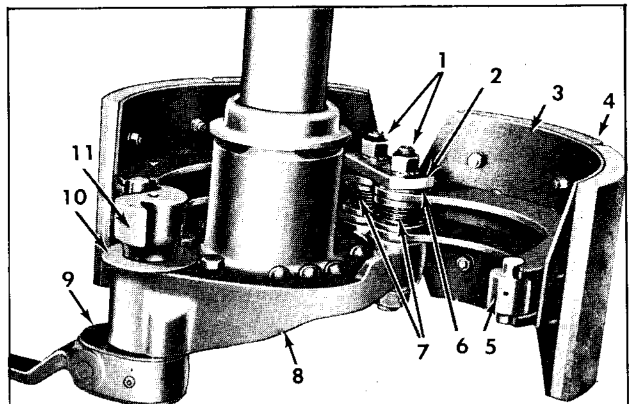
Camshafts are mounted in bushings in brake spider. Mounting is similar to front camshaft mounting shown in figure 9. Lubrication fitting in spider lubricates bushings. Lubricant is retained by seals pressed into spider.

REAR BRAKE SHOE REMOVAL

1. Jack up rear axle and remove wheels and brake drum. Remove hub as directed in "HUBS AND BEARINGS" (SEC. 19) of this manual.
2. Drive plugs out of lining at cam end of upper shoes. Using a hooked tool through holes in linings and shoes, unhook springs from pins in upper shoes. Remove springs from pin in lower shoe.
3. Tag or mark brake shoes so that they may be reinstalled in original position.
4. Remove nut and lock washer from each anchor pin; then remove anchor pin strap and spacing washers. Remove brake shoes and anchor pin springs from anchor pins.

BRAKE SHOE INSPECTION

1. Check anchor pins and brake shoe bushings for wear using "Specifications" at end of this group. Replace badly worn parts with new parts. Burnish brake shoe bushings after installation.
2. Check fit of roller hubs in shoes. Replace worn parts. Lubricate roller hubs before installing roller.
3. Check tension of brake shoe return springs. Replace weak or broken springs.
4. Check thickness of brake lining at center of shoe. If worn down to 5/16" thickness, lining must be replaced. When replacing lining, lining with return spring access holes must be installed at cam end of upper shoes. Linings must be securely bolted to shoe. New lock washers should be used and nuts should be tightened to 18-23 foot-pounds torque. A 0.006" feeler must not enter between lining and shoe at any point. Drive lining plugs into bolt holes in lining when installation is completed. Make sure roller in shoe is standard size when new linings are installed.



1 Anchor Pins	7 Anchor Pin Springs
2 Lock Plate	8 Spider
3 Brake Shoe	9 Slack Adjuster
4 Lining	10 Washer
5 Roller	11 Cam (Integral with Shaft)
6 Washer	

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Figure 11—Rear Brake Shoe Anchor Pins Installed

REAR BRAKE SHOE INSTALLATION

1. Apply a thin coat of Lubriplate to anchor pins, roller hubs, and O.D. of shoe return spring coils.
2. Position each brake shoe heel on anchor pins, with anchor pin springs positioned on shoes, as shown in figure 11.
3. Place one spacing washer on outer end of each anchor pin. Thickness of washer should leave 0.030" to 0.060" clearance between shoe web and anchor strap. Install strap, dowels, lock washer, and nuts on anchor pins. Tighten firmly. Make sure shoes do not bind on pins.
4. Hook one end of brake shoe return spring on pin on lower shoe. Position roller in toe of each shoe; then using a hooked tool through hole in lining and shoe, stretch spring and hook on spring pin in upper shoe. Drive lining plug into hole after hooking spring.
5. Back off slack adjuster worm shaft until shoe rollers rest on lowest points on cam. Install hub, brake drum, and wheel as directed in "HUBS AND BEARINGS" (SEC. 19) of this manual.
6. Adjust brake shoes as previously directed under "Brake Adjustments" in this section.

SERVICE AIR BRAKE SYSTEM

REAR CAMSHAFT REMOVAL

1. Unhook brake shoes as directed in "Rear Brake Shoe Removal," steps 1 and 2. Swing brake shoes away from cam. Rear camshaft mounting is similar to front mounting shown in figure 9.
2. Disconnect brake chamber push rod yoke from slack adjuster. Remove bolt, lock washer, and flat washer securing slack adjuster on camshaft.
3. Pull slack adjuster off end of shaft. Pull camshaft out of brake spider, stripping off spacing washers as shaft is removed.

CAMSHAFT INSPECTION

1. Wash parts in cleaning solvent.
2. Examine camshaft for cracks, distortion, or wear at bearing surface. Replace if worn, or damaged.
3. Examine bushings in brake spider. Replace with new bushings if wear or damage is evident. Replace bushings as follows:
   a. Remove oil seals; then remove bushings by inserting a flat punch through spider and tapping on inside end of each bushing.
   b. Using a suitable driver, carefully drive new bushings into place. Install bushing spacer between bushings. Soak new oil seals in oil for one hour before installing in spider.

REAR CAMSHAFT INSTALLATION

1. Coat bushings in brake spider with lubricant.
2. Place large spacing washer over splined end of camshaft.
3. Insert splined end of shaft through bushings in brake spider.
4. Install spacing washer and slack adjuster on inner end of camshaft. Attach with flat washer, lock washer, and bolt. Connect brake chamber push rod to slack adjuster.
5. Secure brake shoes as directed in "Rear Brake Shoe Installation," steps 4 and 5.
6. Install hubs, brake drums, and wheels as directed in HUBS, WHEELS, AND TIRES (SEC. 19) of this manual.
7. Adjust brake shoes as previously directed under "Brake Adjustments." Lubricate spider bushings and slack adjuster as directed in LUBRICATION (SEC. 13) of this manual.

BRAKE DRUMS

When brake drums become scored, they may be refaced by machining or grinding. To compensate for increased inside diameter of refaced drums, 1/16" and 1/8" oversize brake linings are available from the lining manufacturers. When drums are refaced, they should be machined in increments of 1/16-inch and linings oversize the amount machined from the drum installed.

Satisfactory operation with oversize linings will be obtained until the lining becomes worn sufficiently to permit the brake shoe roller to pass the high point on the cam without effectively applying the brakes.

NOTE: To avoid misunderstanding the term "oversize" as applied to linings and drums, the following example applies:

<u>1/8" Oversize Brake Drum</u>

Inside diameter (I.D.) of the brake drum has been increased 1/8"; that is 1/16" of metal has been removed around the circumference of the drum.

<u>1/8" Oversize Lining</u>

Linings are 1/16" thicker than standard, thus the total increased thickness of linings on both shoes compensates for the 1/8" increased diameter of drum.

Brake drums should never be machined to more than 1/8" beyond original diameter.

SPECIFICATIONS

BRAKE APPLICATION VALVE

PISTON RETURN SPRING

Free Length (Approx.)	2 11/32"
Compressed Length (Max.)	1/2"
Load at 1 3/4" Length	7 1/4 lbs. ± 3/4 lb.
Load at 3/4" Length must increase	12 1/4 lbs. ± 1 1/4 lb.

INLET VALVE SPRING

Free Length (Approx.)	49/64"
Compressed Length (Max.)	15/64"
Load at 41/64" Length	1 lb. ± 2 oz.
Load at 33/64" Length must increase	1 lb. ± 2 oz.

REAR BRAKE RELAY VALVE

VALVE SPRING

Free Length (Approx.)	1 11/32"
Compressed Length (Max.)	39/64"

VALVE SPRING (Cont.)

Load at 63/64" Length	6 3/4 lbs. ± 10 oz.
Load at 45/64" Length must increase	5 1/4 lbs. ± 8 oz.

SPECIAL LUBRICANT

A barium base grease, such as Bendix-Westinghouse BW-204-M, Freedom-Valvoline Oil Company X-5, or equivalent should be used for lubrication when assembling the following units:

Low Air Pressure Switch	Inversion Valve
Brake Application Valve	DD3 Brake Actuators
Rear Brake Relay Valve	Air Compressor and
DD3 Control Valve	D-2 Governor (Except O-rings)

Note: Use a silicone base lubricant on O-rings in D-2 Governor and Compressor Unloader Pistons.

SPECIFICATIONS (CONT.)

	FRONT	REAR
Brake Size	14½″ x 5″	14½″ x 8″
Brake Drum		
Inside Diameter	14.500″-14.510″	14.500″-14.510″
Width Braking Surface	5″	8″
Maximum Allowable Out of Round	0.010″	0.010″
Brake Lining		
Width	5″	8″
Thickness	¾″	¾″
Piece Per Shoe	2	2
Effective Brake Area	294 sq. in.	470 sq. in.
Brake Shoe Return Spring		
Free Length	$8\frac{11}{16}$″	8½″
Length @ Lbs. Pull	$9\frac{13}{32}$″ @ 32-38	$9\frac{13}{32}$″ @ 113-137
Camshaft		
Length of Shaft	$7\frac{15}{16}$″	$5\frac{31}{64}$″
Diameter at Bushings	1.493″-1.495″	1.493″-1.495″
Width of Cam	1.750″	2.340″
Bushing		
Width	1.245″-1.255″	1.245″-1.255″
Outside Diameter	1.876″-1.878″	1.876″-1.878″
Inside Diameter	1.501″-1.503″	1.501″-1.503″
Cam Roller In Shoe		
Diameter of Roller	1.488″-1.492″	1.488″-1.492″
Diameter of Hub	0.740″-0.745″	0.740″-0.745″
Anchor Pins		
Outside Diameter	1.2465″-1.2485″	1.2465″-1.2485″
Length	4⅜″	6⅞″
Bushing		
Width	⅝″	⅝″
Outside Diameter	1.503″-1.505″	1.503″-1.505″
Inside Diameter	1.255″-1.257″	1.255″-1.257″
Spring		
Free Length	—	0.88″-0.91″
Compressed Length	—	0.63″-0.66″
Brake Chambers		
Type	24	30
Diameter (Overall)	7¼″	8⅛″
Spring Force at 0 Stroke	30¾ lbs.	39 lbs. ± 5 lbs.
Spring Force Increase Per Inch of Stroke	8 lbs.	11½ lbs. ± 1½ lbs.
Maximum Stroke	2¼″	2½″
Minimum Stroke (with Brake Adjusted)	⅝″-¾″	1⅛″—1¼″
Effective Diaphragm Area	24 sq. in.	30 sq. in.
Slack Adjusters		
Type	20-2	20-2
Length Between Hole Centers	5¼″	7″
Bushing		
Width	0.484″	0.484″
Inside Diameter	0.504″	0.504″
Outside Diameter	0.628″	0.628″
Spring		
Free Length	$1\frac{9}{64}$″	$1\frac{9}{64}$″
Compressed Length	$\frac{19}{64}$″	$\frac{19}{64}$″

DD3 Parking and Emergency Air Brake System

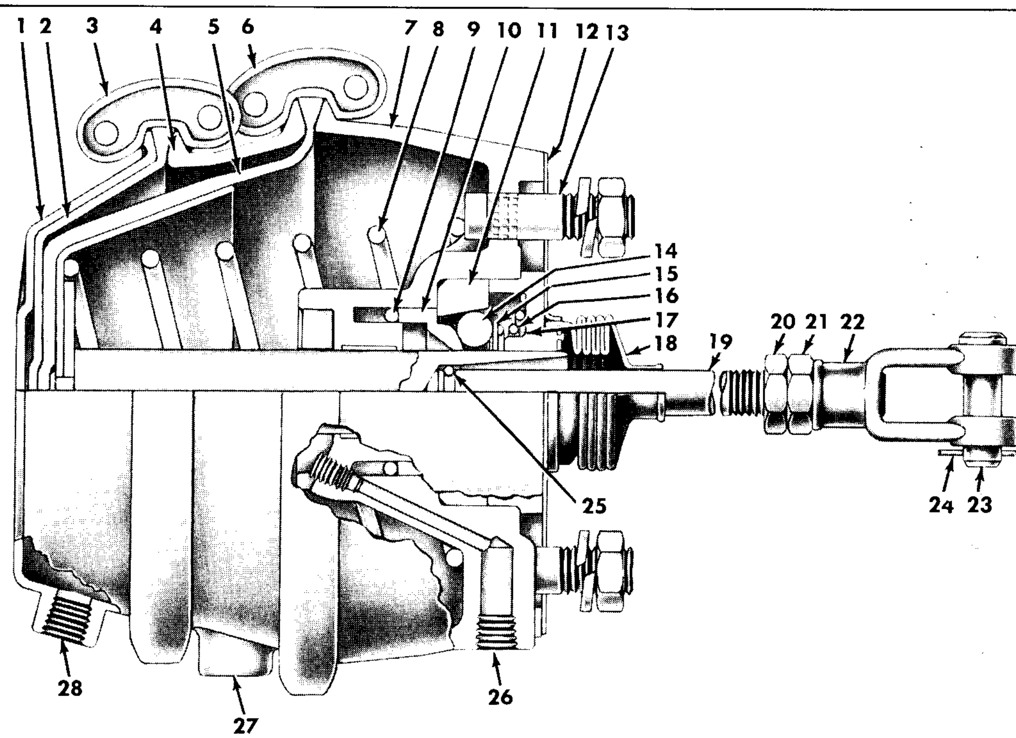
DD3 BRAKE ACTUATOR

OPERATION

(Refer to Figure 1)

NORMAL RUNNING

Through the push-pull control valve and an inversion valve, air enters the actuator locking port and exerts pressure on the locking piston. The resultant force moves the locking piston forward against the rollers and roller spring. The beveled, or ramp, end of the piston will pick up and hold the rollers away from the shaft. As long as air pressure remains against the locking piston and the rollers are not in contact with the shaft, normal service brake applications will permit the shaft to move freely, back and forth, past the locking mechanism. When a normal service brake application is made, air enters the actuator service port and applies pressure agains the service diaphragm. The diaphragm moves the push plate and shaft out, applying the brakes. Upon the release of the service application, the brakes are released.



1 Auxiliary Pressure Plate
2 Auxiliary Diaphragm
3 Auxiliary Clamp Ring
4 Service Pressure Plate
5 Service Diaphragm
6 Service Clamp Ring
7 Non-Pressure Plate
8 Return Spring
9 Piston Grommet
10 Piston
11 Collar
12 Splash Guard
13 Mounting Bolt
14 Roller
15 Spring Seat Washer
16 Roller Spring
17 Lock Cap
18 Boot
19 Push Rod
20 Lock Nut
21 Adjusting Nut
22 Clevis
23 Clevis Pin
24 Cotter Pin
25 Retainer Ring
26 Lock Port
27 Service Port
28 Parking and Emergency Port

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Figure 1—DD3 Brake Actuator Assembly

PARKING

To park, air is exhausted from the locking port and air is applied against the parking diaphragm through the parking diaphragm port. When air is exhausted from the lock piston, the roller spring forces the rollers against the collar and shaft. Air entering the parking port exerts force on the parking diaphragm. The diaphragm moves the push plate and shaft out, applying the brakes. With no air on the lock piston, the shaft becomes mechanically locked in the applied position as the rollers wedge between the shaft and collar.

NOTE: While in a parked position, when there is a loss of air pressure on the parking diaphragm, the output force on the shaft is reduced. However, the shaft will not retract since its output force is transferred to the mechanical lock mechanism.

RELEASE OF PARKING APPLICATION

To release a parking application of the DD3 brake actuator, it is necessary to re-apply air pressure to equal a shaft force approximately the same as was used in making the parking application. This is necessary to release the locking rollers so they can be moved away from the shaft when air is re-applied to the locking piston. This can be accomplished by making a 100 psi service application after the push-pull control valve is "in" to release the parking application.

To release a parking application, air enters the locking piston and the air on the parking diaphragm is exhausted. A full 100 psi service brake application will be necessary to force the shaft forward sufficiently to allow the locking rollers to disengage and unlock the shaft. Upon release of the service application, the return spring will return the shaft to the release position.

In the event of a loss of air from the service system and it becomes necessary to move the vehicle before service air can be restored, the brakes may be manually released as follows:

IMPORTANT: BLOCK WHEELS OF VEHICLE BEFORE RELEASING BRAKES.

Exhaust any air pressure remaining in the parking reservoir by opening drain cock, then back off the slack adjuster at each rear brake chamber. If necessary, disconnect slack adjuster from chamber push rod clevis.

PREVENTIVE MAINTENANCE

Depending on experience and type of operation, the drain slot in the actuator non-pressure plate should be checked and cleared periodically.

Brakes should be adjusted as is customary with any brake chambers. Push rod travel should be as short as possible without brakes dragging. Excessive travel not only shortens the normal service life of diaphragms but gives slow braking response, wastes air, and decreases brake torque output.

Push rod to slack adjuster alignment should be checked in both the applied and released positions, the rod should move out and return properly without binding. Also, check the angle formed by the slack adjuster arm and push rod. It should be 90° or greater in any position, after adjustment.

AT BRAKE RELINE
(OR AT LEAST ONCE A YEAR)

Inspect DD3 brake actuator diaphragm and replace if necessary. Disassemble DD3 brake actuator, clean all parts and lubricate locking mechanism. A special barium base grease (or its equivalent) is recommended as a lubricant. This grease is available from GMC Parts Warehouses.

When diaphragms or return spring or both are replaced, like parts in the other brake actuator should also be replaced.

OPERATING AND LEAKAGE CHECKS

OPERATING

With the brake actuator in the released position, make several service brake applications and note that actuators apply and release properly. Operate parking push-pull control valve and observe that actuators apply. While actuators are in a parking position, drain air supply to parking diaphragm and note that actuators remain applied.

Replenish air supply to auxiliary diaphragm. Operate push-pull control valve to release parking application, then make a 100 psi service application to complete release of actuators. The magnitude of the service brake application to release the brakes may vary on different vehicles due to compressor governor settings. A service application of approximately 100 psi will release brakes.

LEAKAGE

With air system at maximum governor pressure and DD3 brake actuators in the released position, check drain slot and around the push rod boot with a soapy solution to detect possible leakage by the locking piston grommet.

Make and hold a service brake application and again check the actuator drain slot for service diaphragm leakage. Continue to hold the service application and coat around the service and parking diaphragm clamping rings with the soapy solution to detect seal leakage.

Operate the actuator control valve to a parking position and check the exhaust port of a service brake application to detect parking diaphragm leakage. This parking diaphragm leakage detection point could be the exhaust port of the foot brake valve, quick release valve or relay valve. While still in a parking position, the parking diaphragm

DD3 BRAKE ACTUATOR SYSTEM

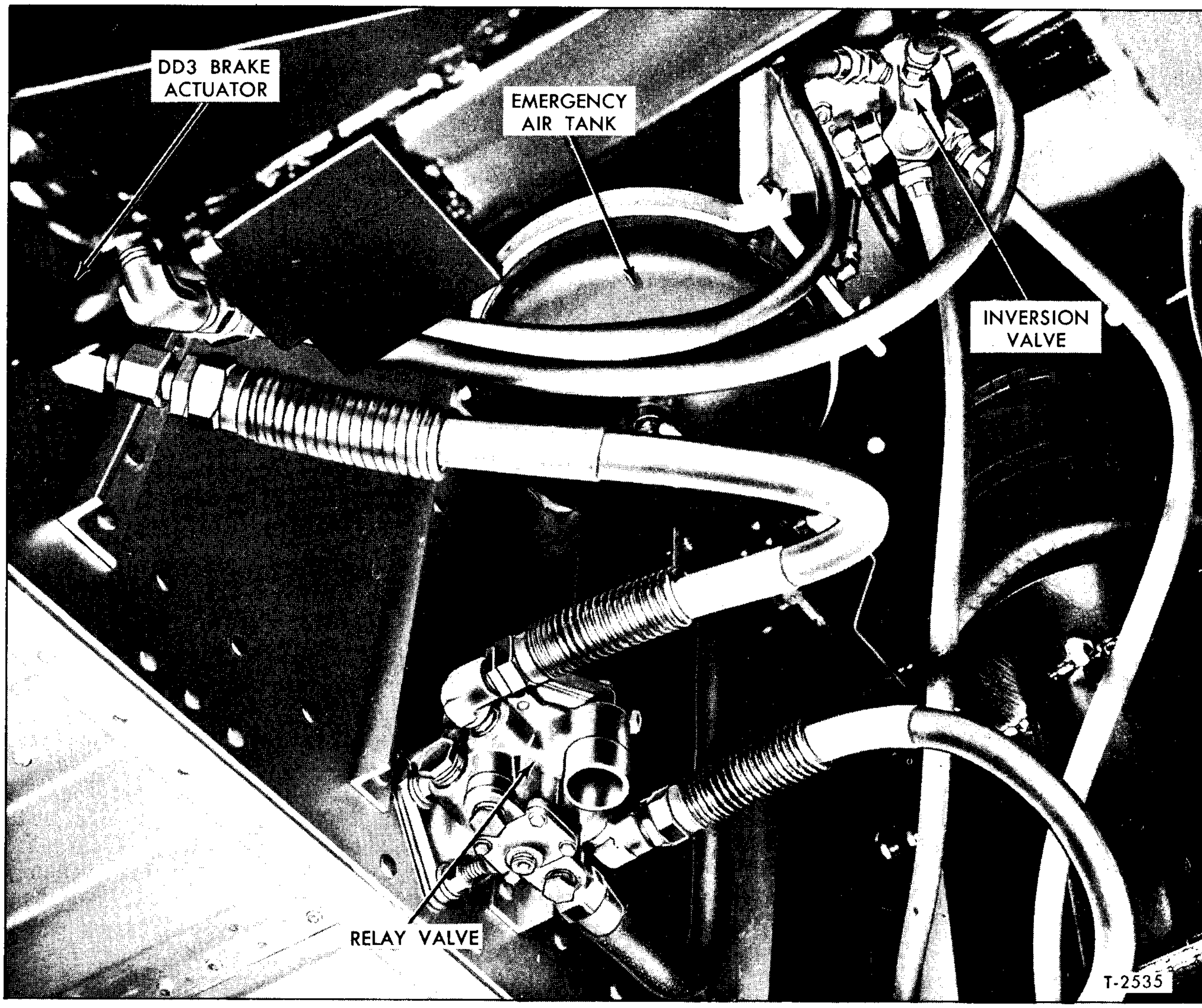


Figure 2—DD3 Brake Actuator System Installed

clamping ring should be coated with the soap solution to detect seal leakage.

Should leakage be detected at the clamping rings in either of the above tests, the clamping ring nuts should be tightened evenly but only enough to stop leakage.

If the DD3 brake actuator does not function as described, or leakage is excessive, it is recommended that it be repaired or replaced.

REPLACEMENT

(Refer to Figures 2 and 3)

REMOVAL

1. Block and hold vehicle by some means other than air brakes.
2. With the brake actuators in the released position, disconnect or completely remove air brake hoses from parking and service ports of the actuator.
3. At this point, exhaust air from parking reservoir. This may be done by opening the drain cock in the reservoir tank or by pulling out the push-pull control valve button.

NOTE OF CAUTION: Air will be exhausted out the line that was connected to the parking port, if the push-pull control valve is operated. If this line is not removed, it should be disconnected in such a way that it will not whip and cause damage as the air exhausts.

4. As a safety precaution, the service system should also be drained.

5. Disconnect air brake hose at actuator lock port.
6. Remove yoke pin cotter pin and knock out yoke pin.
7. Remove mounting nuts, then actuator.

INSTALLATION

IMPORTANT: DD3 brake actuators must be installed with the drain slot pointing down and towards the center line of the vehicle.

1. Mount actuator to mounting bracket and tighten securely.
2. Fasten actuator push rod yoke to slack adjuster with yoke pin. Lock yoke pin with cotter pin. The angle formed by the push rod and slack adjuster arm should be greater than 90°.
3. Connect air brake hoses to actuator, taking precautions that the proper hose is installed in the correct port, and hoses are positioned for proper movement during coach operation.
4. Adjust brakes.
5. Build up air pressure in system and test operation of brakes.
6. Test for leaks.

DISASSEMBLY

(Refer to Figure 4)

1. Clean brake actuator exterior of all road grime. Mark it in such a way that it can be reassembled correctly.
2. Remove yoke and yoke lock nuts.
3. Remove boot, splash guard and felt breather.
4. Remove auxiliary and service clamping ring nuts and bolts. Spread clamping rings slightly, just enough to slip them off the plates. It may be necessary to use a soft mallet driver to break the clamping rings loose. If the rings are being reused, caution should be taken against bending them out of shape.
5. After clamping rings are removed, auxiliary pressure plate, parking diaphragm, service pressure plate and service diaphragm are removed in that order.
6. Place the remains of actuator on a smooth surface with the push plate down. Connect an air supply (shop air) line to the locking port. By hand press down on the actuator non-pressure plate and at the same time apply air to the locking port. As the shaft is unlocked, ease the non-pressure plate back and remove push plate and shaft assembly with push rod and return spring.
7. Hold lock cap down against roller spring tension and completely remove all four (4) cap screws before releasing and removing cap.
8. Remove roller spring and spring seat washer.
9. Remove all eight (8) rollers.
10. Next cautiously apply air at the locking port to assist in removal of collar and piston, and to remove piston grommet.
11. Inspect bearing in shaft bore of non-pressure plate and remove it only if it is showing signs of wear and is to be replaced.
12. The push rod should not be removed from the shaft unless it is damaged. If the rod is removed it must be replaced. To remove the rod, place a heavy washer over the rod against the shaft, then position a spacer and second washer over the rod and beneath the yoke lock nut(s). Turn the lock nut(s) down with a long handled wrench, pulling the push rod from the shaft.
13. The knurled T-bolts in the non-pressure plate can be removed and replaced if damaged.

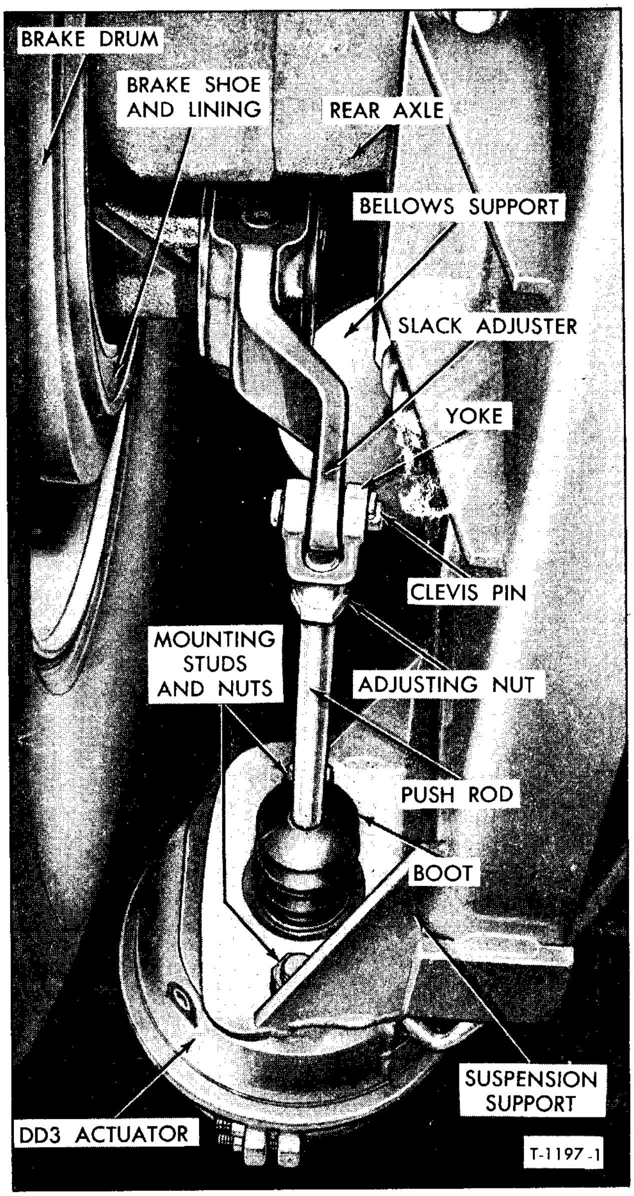


Figure 3—DD3 Brake Actuator Installed

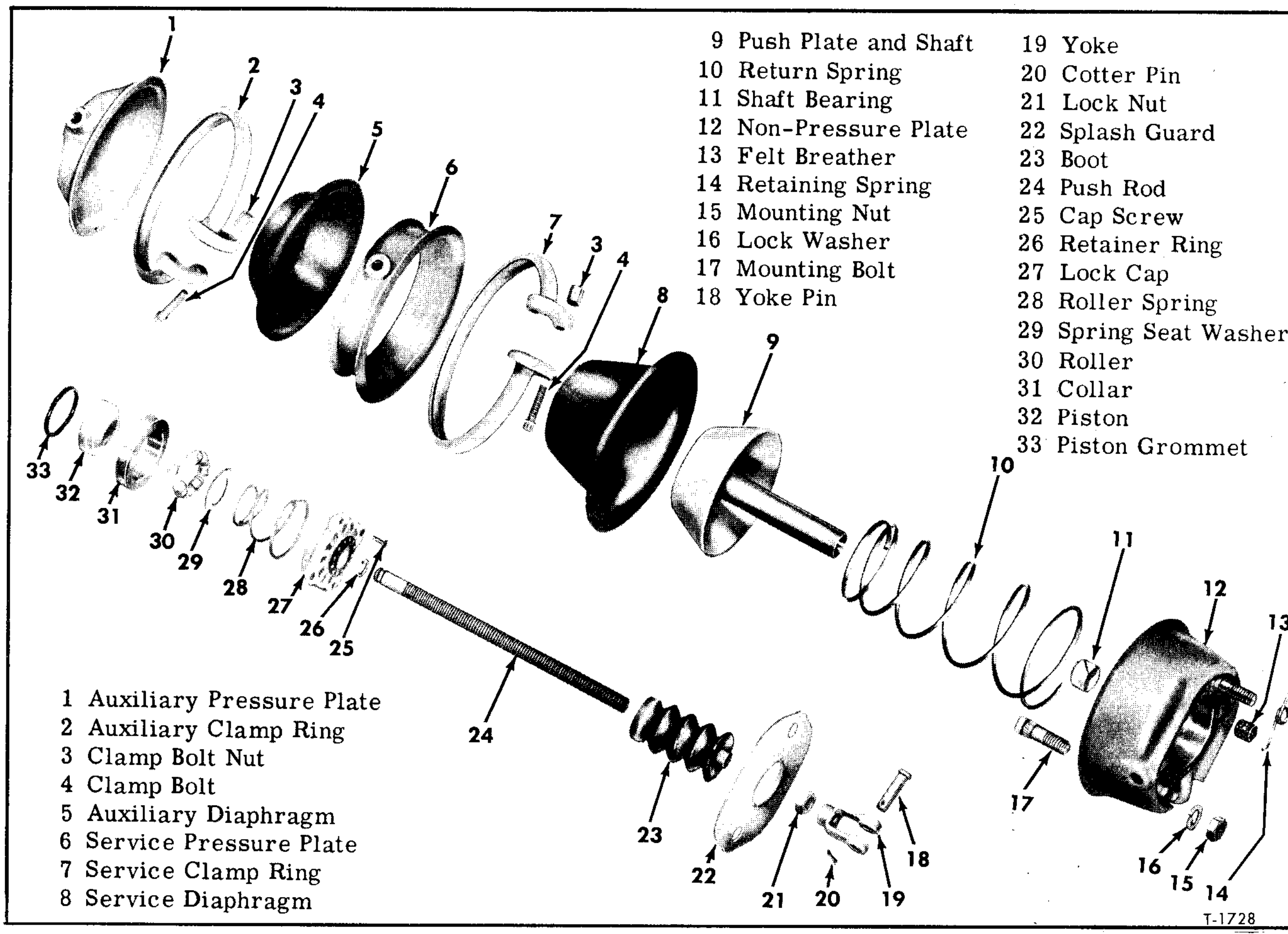


Figure 4—DD3 Brake Actuator Assembly Components

CLEANING AND INSPECTION

Wash all metal parts in a good cleaning solvent. Dry thoroughly. Any reuseable rubber parts should be wiped clean. Discard felt breather. Inspect all parts for excessive wear or deterioration. Particular attention should be given to the piston and collar bores in the plate. Also, the air passage from the lock port to piston bore should be clean and not restricted. It may be necessary to remove the inspection plug to thoroughly clean this passage.

Rollers should be checked carefully and all replaced if any need replacing. Check springs for cracks, distortion or corrosion.

Replace all parts not considered serviceable during these inspections, especially rubber parts.

ASSEMBLY

1. Prior to assembly, line up parts as they were marked prior to disassembly.
2. If the bearing in the non-pressure plate was removed it should be reinstalled or replaced.
3. Lubricate piston and collar bores, shaft, piston grommet, piston and roller cavity. See "Specifications" at end of "SERVICE AIR BRAKE SYSTEM" section of this group, for description of lubricant.
4. Position piston grommet in piston bore, then piston, with smooth end down, against grommet.
5. Place collar in its bore in non-pressure plate.
6. Position all eight (8) rollers in groove formed by top of piston and collar ramp.
7. Place roller spring seat washer on top of rollers.
8. Position cone shaped roller spring on washer with small end to washer.
9. Position cap on roller spring. Press cap down and hold while installing cap screws evenly and securely.
10. Turn over non-pressure plate with lock mechanism installed and position return spring in plate with large end down.
11. Position push plate and shaft over return spring and press down so shaft moves through lock.

The lock should hold shaft position against return spring. If not, check assembly to this point.

12. Install service diaphragm, service pressure plate and clamping ring.

13. Install auxiliary diaphragm, auxiliary pressure plate and clamping ring.

14. Tighten clamping ring bolts in both clamping rings evenly and securely.

15. Install boot and new felt breather, then splash guard down over boot.

16. Perform checks as outlined in "Operating and Leakage Checks."

INVERSION VALVE

DESCRIPTION

(Refer to Figure 5)

The inversion valve is used in combination with the DD3 brake actuators and push-pull control valve in a parking and/or emergency system. When the push-pull control valve is operated, the inversion valve operates permitting air in the parking reservoir to apply the brakes. The inversion valve also operates automatically when air pressure drops to a predetermined pressure (40 psi).

The inversion valve employs a 1-1/4" diameter hole mounting. The valve serves as a manifold having a total of six (6) 1/4" pipe ports; three (3) control ports, two (2) delivery ports and one (1) supply port. These ports are identified. The control ports are marked "C," supply "S" and the delivery ports are marked "D." The exhaust port is protected by a diaphragm.

OPERATION

With no air pressure in the system, the inversion valve inlet valve is open and its exhaust is closed. On initial build-up, as air enters the parking reservoir to which the inversion valve supply port is connected, it will pass by the open inlet and out the delivery ports. When system air pressure reaches between 50 and 60 psi and the push-pull control valve is pushed in, air will pass into the inversion valve from the push-pull control valve. This air flows in one control port and exerts a force on the inversion valve piston. At a pressure between 60 and 70 psi, the piston moves against the resistance of the two (2) piston springs. The piston exhaust seat moves away from the inlet and exhaust valve, opening the exhaust passage. The inlet valve spring and supply air at the inlet valve will cause it to seat. Air at the inversion valve delivery will now exhaust from valve exhaust port.

PARKING OR EMERGENCY

The air at the inversion valve control ports is exhausted through the push-pull control valve exhaust when it is operated. The piston springs will then cause the piston to move and seat on the inlet and exhaust valve closing the exhaust passage. The inlet valve is moved off its seat by the piston, so that supply air from the parking reservoir will pass by the open inlet and out the delivery ports.

When the application is released by pushing in on the push-pull control valve, air passes into the inversion valve control port. The piston moves away from the inlet and exhaust valve, opening the exhaust passage through the piston. The inlet valve closes and air in the delivery ports will exhaust through the center of piston stem and out the inversion valve exhaust port.

PREVENTIVE MAINTENANCE

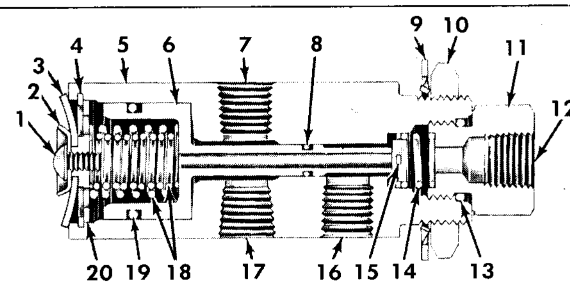
Every year or after 50,000 miles the inversion valve should be disassembled, cleaned and lubricated. Lubricate with a barium base grease (or equivalent).

Rubber parts should be replaced and any other parts which show signs of wear or damage should also be replaced.

OPERATING AND LEAKAGE CHECKS

OPERATING

With the air brake system built up to governor



1 Cap Screw	12 Supply Port
2 Diaphragm Washer	13 Seal Ring
3 Exhaust Diaphragm	14 Inlet and Exhaust Valve Spring
4 Retainer Ring	15 Inlet and Exhaust Valve
5 Valve Body	16 Delivery Port
6 Piston	17 Control Port
7 Control Port	18 Piston Springs
8 Piston Grommet (Small)	19 Piston Grommet (Large)
9 Lock Washer	20 Cover Plate
10 Mounting Nut	
11 Cap Nut	

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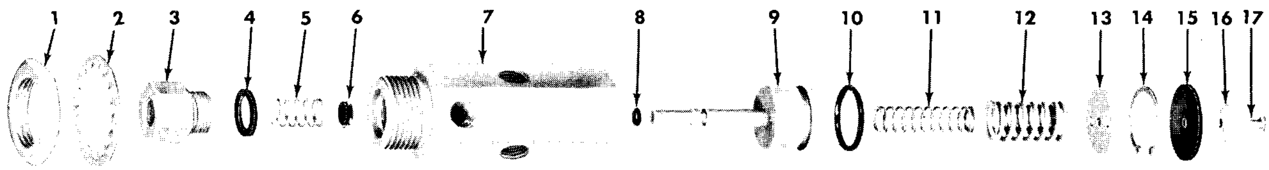
Figure 5—Inversion Valve Assembly



1 Mounting Nut
2 Lock Washer
3 Cap Nut
4 Seal Ring
5 Inlet and Exhaust Valve Spring
6 Inlet and Exhaust Valve
7 Valve Body
8 Piston Grommet (Small)
9 Piston
10 Piston Grommet (Large)
11 Piston Spring (Small)
12 Piston Spring (Large)
13 Cover Plate
14 Retainer Ring
15 Exhaust Diaphragm
16 Diaphragm Washer
17 Capscrew

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Figure 6—Inversion Valve Assembly Components

cut-out pressure and the brakes released, operate by pulling out the push-pull control valve button to apply the brakes. Note that the brakes apply.

Operate by pushing in the push-pull control valve to release the brake application and note that the delivered air from the inversion valve is exhausted out its exhaust port. The operation of the push-pull control valve will not necessarily complete the release of the brakes. A full 100 psi service brake application after the push-pull control valve is pushed in should complete the release.

LEAKAGE

Start leakage checks with system pressure up to governor cut-out and brakes released. Check the inversion valve exhaust port for possible leakage at (1) the large piston grommet; (2) piston stem grommet or; (3) the inlet valve or its seat. Slight leakage is permissible. While the inversion valve is still in this position, the cap nut should be checked for leakage by the seal ring.

Actuate push-pull control valve by pulling out on the button to apply the brakes, then check the inversion valve exhaust port for exhaust valve or seat leakage.

If the inversion valve does not function as described or leakage is excessive, it is recommended that it be repaired or replaced.

REPLACEMENT
(Refer to Figure 2)

REMOVAL

1. Block and hold vehicle by means other than air brakes.
2. Drain service and parking reservoir air supply.
3. Disconnect air lines and air brake hoses from inversion valve.
4. Loosen valve mounting nut and remove valve.

INSTALLATION

1. Check and clean air lines to valve.
2. Mount valve securely with mounting nut and lock washer.
3. Connect air lines and air brake hoses.
4. Check for proper operation and leaks.

DISASSEMBLY
(Refer to Figure 6)

1. Remove cap nut with sealing ring, remove sealing ring from cap nut.
2. Turn valve over and remove exhaust check valve diaphragm cap screw with lock washer, then diaphragm washer and diaphragm.
3. With a pair of snap ring pliers, remove retainer ring.
4. Remove cover plate and two (2) piston springs.
5. Remove piston with grommets.
6. Remove piston grommets.

CLEANING AND INSPECTION

Wash all metal parts in a good cleaning solvent. Rubber parts should be wiped clean. Inspect all parts for excessive wear or deterioration. Check springs for cracks, corrosion, or distortion. Inspect piston and its exhaust seat, body bores and inlet valve seat for nicks or burrs. Replace all parts not considered serviceable during these inspections.

ASSEMBLY

Before assembling the valve, lubricate the piston, grommets and body bores. See "Specifications" at end of "SERVICE AIR BRAKE SYSTEM" section of this group for description of lubricant.

1. Install piston grommets on piston.
2. Install piston with grommets in valve body.
3. Position piston springs, cover plate and retainer ring in the valve body in that order.
4. Press the cover and retainer down and with a pair of snap ring pliers snap the ring into the

body groove.

5. Install the diaphragm and diaphragm washer and secure with cap screw.

6. Turn inversion valve over and position inlet and exhaust valve in its bore.

7. Place spring down over inlet valve.

8. Install sealing ring on cap nut, install cap nut with sealing ring and tighten securely.

9. Mounting nut and lock washer are installed when valve is mounted on vehicle.

10. Perform "Operating and Leakage Checks" as outlined in this section.

PUSH-PULL CONTROL VALVE

DESCRIPTION

The push-pull control valve is located on a panel to the right of the driver's seat (see fig. 7). For a cross-section view of the valve refer to figure 8. The valve has a black knob which moves in and out ("push-pull") for operation. A red colored ring on the knob, when exposed, indicates that parking brake is on. The valve has four ports; two delivery, one supply and one for connection to the service brake foot control valve. The push-pull valve directs the flow of air to the DD3 brake actuator through the inversion valve. The direction of flow is controlled within the valve by a combination inlet and exhaust valve in conjunction with the position of the knob ("push" for service, - "pull" for parking).

OPERATION

For operation of the push-pull control valve, refer to figure 8 and the description given previously under "Service Brake Operation," "Parking Operation" and "Emergency Operation" in "GENERAL" section of this group.

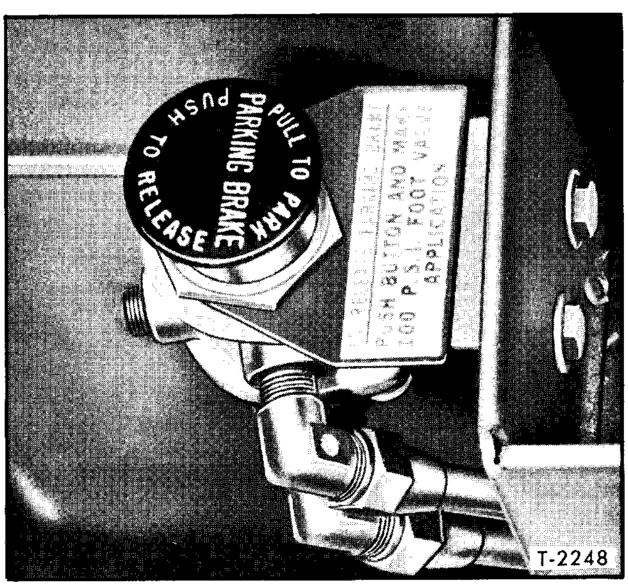


Figure 7—Push-Pull Control Valve Installed

REPLACEMENT

REMOVAL

1. Secure vehicle by some means other than air brakes.

2. Exhaust air from parking brake system. It is unnecessary to exhaust service air.

3. Disconnect air lines from push-pull control valve. Mark lines to assure installation in correct valve ports when replacing valve.

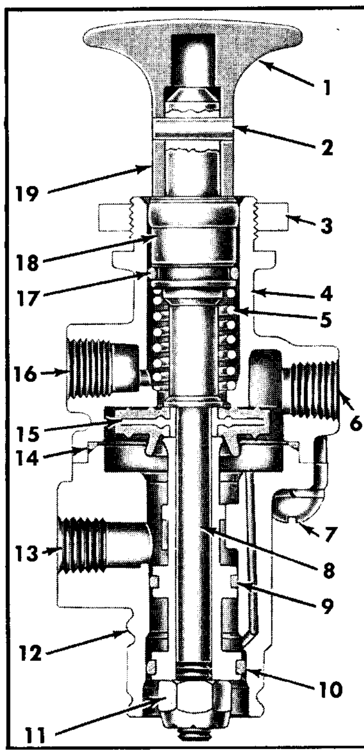
4. Drive spirol pin out of button and remove button.

5. Remove mounting nut from valve body and remove valve from mounting bracket.

INSTALLATION

1. Position valve on mounting bracket and secure with mounting nut.

2. Place button on plunger shaft, line up hole in button with hole in plunger shaft and drive in



1 Button
2 Spirol Pin
3 Mounting Nut
4 Valve Cover
5 Spring
6 Delivery Port
7 Cover Screw
8 Piston
9 Piston Grommet (Small)
10 Piston Grommet (Large)
11 Nut
12 Valve Body
13 Exhaust Port
14 Seal Grommet
15 Inlet and Exhaust Valve
16 Supply Port
17 Plunger Grommet
18 Plunger
19 Warning Ring (Red)

Figure 8—Push-Pull Control Valve Assembly

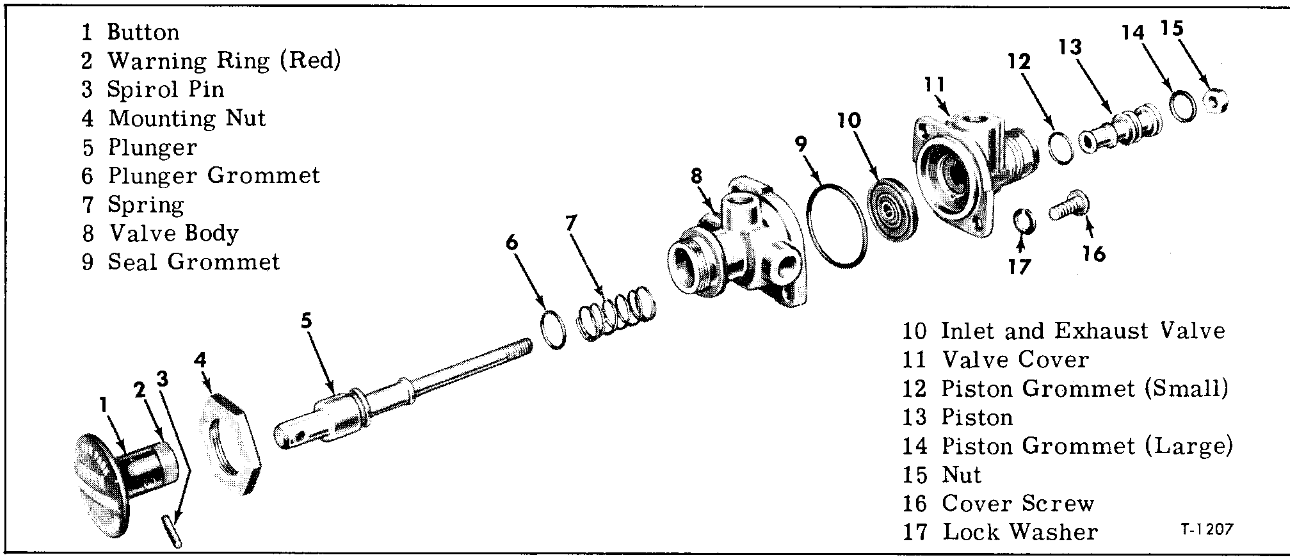


Figure 9—Push-Pull Control Valve Assembly Components

spirol pin.

3. Connect air lines to push-pull control valve ports making sure lines are connected to correct ports.

4. Build up vehicle air pressure system, and check valve for operation and leaks.

DISASSEMBLY

(Refer to Figure 9)

1. The spirol pin button and mounting nut are removed at the time the valve is removed from the vehicle.

2. Insert a rod or punch in the plunger pin hole to keep plunger from turning while removing nut at bottom of valve.

3. Remove plunger and spring.

4. Remove plunger grommet.

5. Remove the two cover screws and separate the cover from the body.

6. Remove the cover seal grommet and the inlet and exhaust valve.

7. Remove the piston.

8. Remove the large (lower) piston grommet, then the small (upper) piston grommet.

CLEANING AND INSPECTION

Wash all metal parts in a good cleaning solvent. Dry thoroughly. Wipe reuseable rubber parts clean. Inspect all parts for excessive wear or deterioration. Inspect plunger and piston bores for nicks and burrs. Check springs for cracks, distortion and corrosion. Inspect the inlet and exhaust valve and all grommets for wear or deterioration.

Replace all parts not considered serviceable, especially rubber parts.

ASSEMBLY

Prior to assembly, lubricate all grommets and bearing surfaces of the body and cover. See "Specifications" at end of "AIR BRAKE SYSTEM" section of this group for description of lubricant.

1. Install grommet on plunger.

2. Place spring on plunger.

3. Insert plunger, with spring and grommet installed, in body.

4. Install inlet and exhaust valve over protruding end of the plunger. The double beaded side of the inlet and exhaust valve should be up against the body seat.

5. Position cover to body seal grommet in body.

6. Attach cover to body with two screws.

7. Install piston grommets (large grommet in bottom piston groove; small grommet in top piston groove).

8. Install the piston with grommets.

9. Depress the plunger and, with a punch or rod, hold it from turning while installing the plunger stem nut. Torque on the stem nut should be between 30 and 40 inch-pounds.

10. The control button should be installed and held in place by the spirol pin after the valve is mounted.

11. After valve is installed, check for operation and leaks.

HAND BRAKE TELL-TALE SWITCH

The DD3 tell-tale lamp (marked "BRAKE" in instrument panel) is operated by an air pressure switch mounted in the line from the DD3 control valve to the inversion valve. This switch is iden-

tical to the low air pressure alarm system switch. Complete operation, maintenance, and repair procedures are outlined under "Low Air Pressure Switch" in "AIR SUPPLY AND CONTROL" section of this group. Operation of tell-tale alarm system is explained in "WIRING AND MISCELLANEOUS ELECTRICAL" in ELECTRICAL (SEC. 7) of this manual.

SPECIFICATIONS

BRAKE ACTUATOR

Model DD3
Working Stroke (Approx.) . . . . . 3″
Ports
  Service . . . . . $\frac{1}{4}$″ dryseal thread
  Parking . . . . . $\frac{1}{4}$″ dryseal thread
  Emergency . . . . . $\frac{1}{4}$″ dryseal thread
Chamber Length (Approx.) . . . . . $7\frac{5}{32}$″
Diameter . . . . . $8\frac{1}{8}$″
Spring Force at 0 Stroke . . . . . 39 lbs. ± 5 lbs.
Increase per Inch of Stroke . . . . . $11\frac{1}{2}$ lbs. ± $1\frac{1}{2}$ lbs.

INVERSION VALVE

Model TR-2
Ports
  Control (3)—stamped "C" . . . . . $\frac{1}{4}$″ pipe thread
  Delivery (2)—stamped "D" . . . . . $\frac{1}{4}$″ pipe thread
  Supply (1)—stamped "S" . . . . . $\frac{1}{4}$″ pipe thread
Body Size . . . . . $1\frac{1}{2}$″ Hexagon
Springs
  Inlet and Exhaust Valve Spring
    Free Length . . . . . $\frac{53}{64}$″
    No. of Active Coils 4
    Load at $\frac{33}{64}$″ height . . . . . $7\frac{1}{2}$ lbs. ± $\frac{1}{4}$ lb.
  Piston Spring (Large)
    Free Length . . . . . $1\frac{11}{32}$″
    No. of Active Coils . . . . . $5\frac{1}{2}$
    Load at $\frac{53}{64}$″ height . . . . . 52 lbs. ± $2\frac{1}{2}$ lbs.
  Piston Spring (Small)
    Free Length . . . . . $1\frac{47}{64}$″
    No. of Active Coils 10
    Load at $\frac{53}{64}$″ height . . . . . 10 lbs. ± $\frac{1}{2}$ lb.

PUSH-PULL CONTROL VALVE

Model PP-2
Ports
  Supply (1) . . . . . $\frac{1}{8}$″ dryseal
  Brake Valve (1) . . . . . $\frac{1}{8}$″ dryseal
  Delivery (2) . . . . . $\frac{1}{8}$″ dryseal
Automatic Release Pressure . . . . . 40 ± 5 psi
Plunger Return Spring
  Free Length . . . . . $1\frac{1}{8}$″
  No. of Active Coils . . . . . $4\frac{1}{2}$
  Load at $\frac{15}{16}$″ height . . . . . 3 lbs. ± 2 oz.

Air Compressor and Governor
(BENDIX-WESTINGHOUSE)

AIR COMPRESSOR

The air compressor is a two-cylinder single-acting, reciprocating type unit. Compressor is flange mounted to the gear train cover at rear end of the engine. Compressor is driven directly from the engine camshaft, and lubricated by the engine lubrication system. The cylinder head and cylinder block are cooled by engine cooling system. Compressor has a rated capacity of 12 cu.ft. per minute based on piston displacement when running at a speed of 1250 rpm.

AIR COMPRESSOR DRIVE AND LUBRICATION

Typical compressor drive is shown in figure 1. A hub with internal fiber teeth is keyed to front end of the compressor crankshaft and secured by a nut and cotter pin. An internal-toothed fiber drive disc is attached to the engine camshaft gear by four cap screws. A drive coupling with external teeth at each end is carried in internal teeth of the hub and drive disc, transmitting power from drive disc to the air compressor crankshaft hub.

Oil, under pressure from the engine lubrication system, enters drilled crankshaft through crankshaft rear end cover and is forced through crankshaft and drilled connecting rods (fig. 8), lubricating bearings, piston pins, and pistons. Oil return is cast integral with compressor crankcase.

Two vent holes through the crankcase above the crankshaft front bearing permit equalization of the compressor crankcase pressure with the engine crankcase pressure.

AIR COMPRESSOR AIR INTAKE

The air compressor air inlet port is connected by a tube to the engine air cleaner manifold. The air drawn into the air compressor is cleaned by the engine air cleaners.

AIR COMPRESSOR OPERATION

Air compressor crankshaft turns continuously while engine is running. Actual compression of air

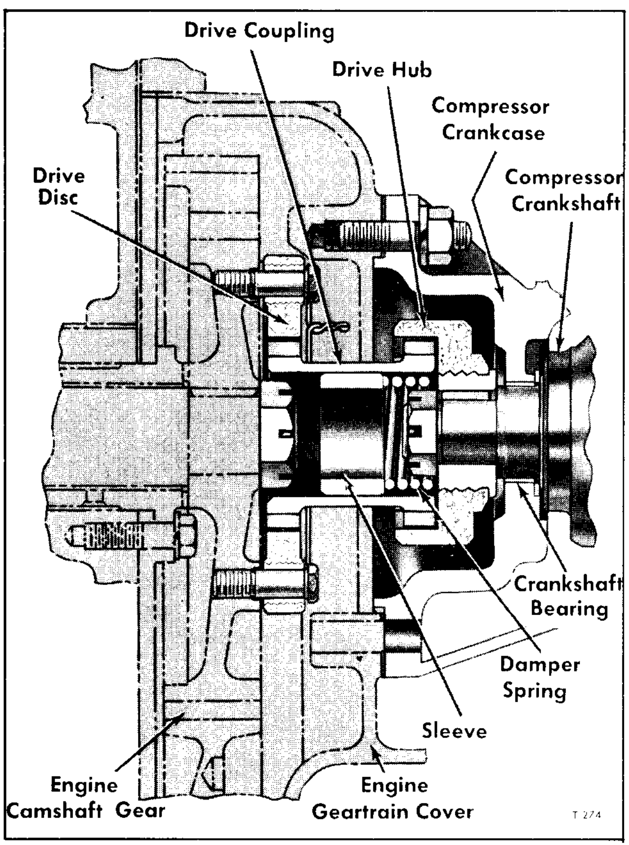


Figure 1—Air Compressor Drive

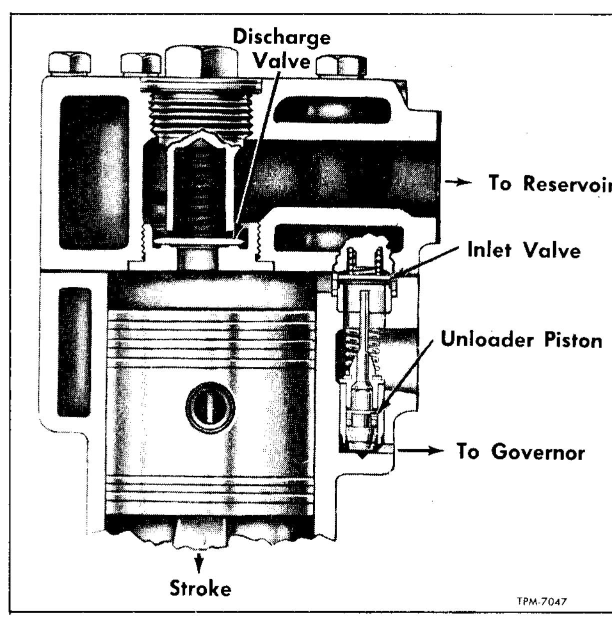


Figure 2—Intake of Air

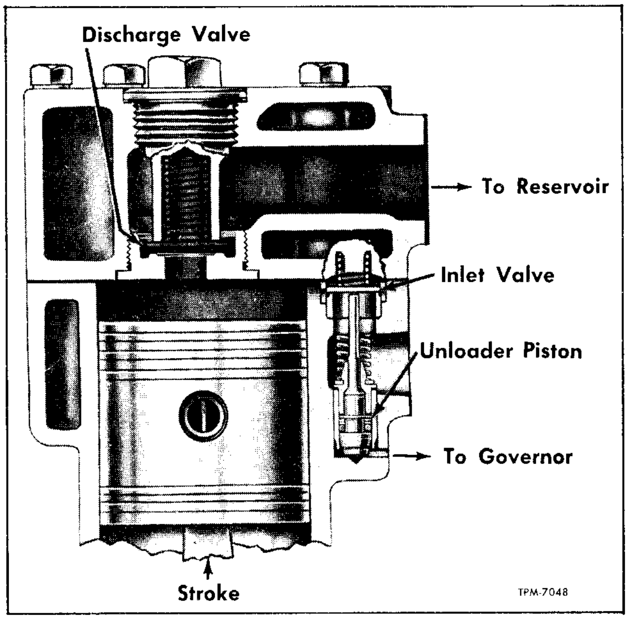


Figure 3—Compression of Air

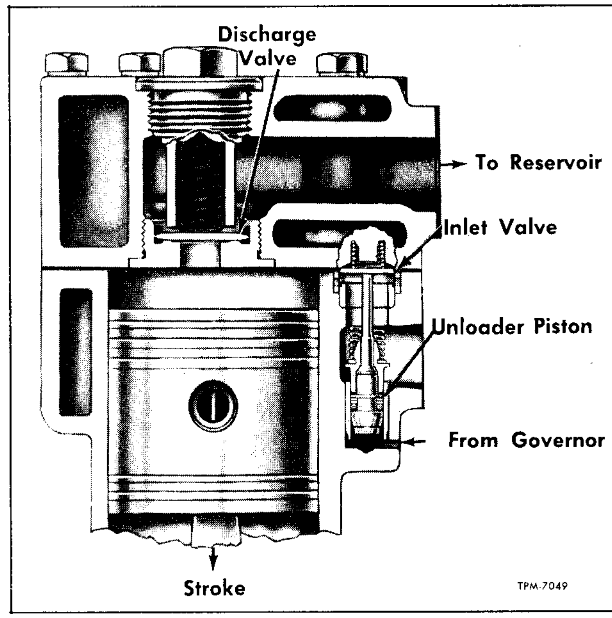


Figure 4—Unloading Compressor

is controlled by the compressor governor, however. Acting with compressor unloading mechanism, governor controls compression of air by loading or unloading compressor when pressure in air system reaches the desired high or low point.

OPERATION WITH UNLOADER VALVE CLOSED (COMPRESSING) (Figs. 2 and 3)

During the downstroke, a partial vacuum is created above each piston. Intake air forces open the inlet valve and air fills cylinder.

As piston starts upstroke, air pressure on top of inlet valve plus inlet valve return spring force closes the inlet valve. As air above piston is further compressed, pressure lifts discharge valve and compressed air is forced through discharge line into reservoir. At start of downstroke discharge valve returns to seat, blocking return flow of compressed air to cylinder as cycle is repeated.

OPERATION WITH UNLOADER VALVES OPEN (NOT COMPRESSING) (Fig. 4)

When air in system reaches maximum pressure for which governor is set, air passes through governor into unloader cavity below unloader piston cups in compressor cylinder block. Upward movement of unloader pistons caused by air pressure lifts both air inlet valves off inlet valve seats. With both inlet valves unseated, air intake cavity in the cylinder block forms a passage between cylinders above the pistons. Upstroke of one piston exhausts air into cylinder of other piston on downstroke, without compression.

When pressure in air system is reduced to governor cut-in setting, the governor releases pressure from beneath unloader pistons. Pressure of unloader spring on unloader spring saddle, acting against reduced governor pressure, forces pistons away from inlet valves. As inlet valve springs in turn overcome reduced plunger pressure, inlet valves reseat and compression is resumed.

AIR COMPRESSOR MAINTENANCE

It is important that inspection and adjustments listed below be made at intervals determined by severity of service.

1. Remove cylinder head and clean carbon away from discharge valves and inlet valves.
2. Check compressor discharge line. Make sure line is not choked with carbon.
3. Check compressor mounting bolts and tighten if necessary.
4. Make sure oil and air lines and connections are tight and free from leaks.
5. When draining engine cooling system to prevent freezing, be sure and remove drain plug from compressor cylinder block.

UNLOADER ASSEMBLY REPLACEMENT

Parts are available in a kit for replacing unloader assembly components. Unloader parts (fig. 5) may be changed without removing cylinder head. Replace parts as follows:

REMOVAL (Fig. 6)

1. Remove air inlet elbow and gasket.

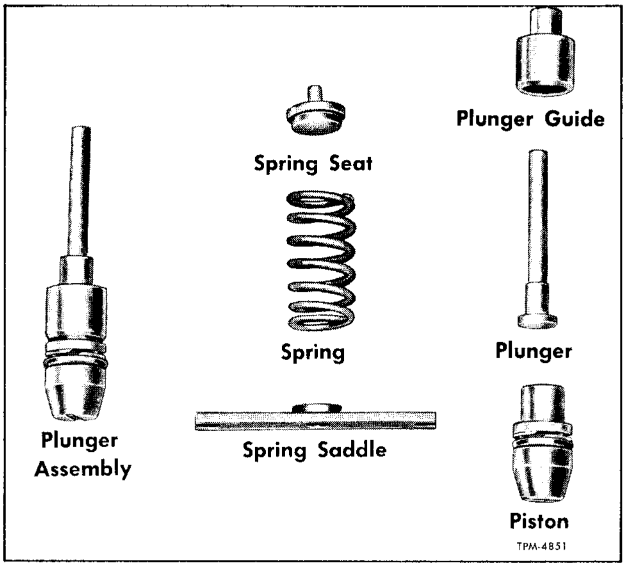


Figure 5—Unloading Assembly Components

2. Insert screwdriver blade under unloader spring and raise spring off unloader spring saddle. Remove spring, spring seat, and spring saddle.

3. Lift each plunger guide and remove guide and plunger. Lift pistons out of bores. If piston is not easily removed, build up air pressure in system until governor cuts out raising piston. If compressor has been removed from vehicle, use air pressure as shown in figure 6.

INSTALLATION (Fig. 7)

1. Carefully insert each piston, complete with new O-ring and back-up ring, in bore.

2. Slide plunger guide down over unloader plunger. Place each guide and plunger in position above unloader piston, then push guide down over top of piston.

3. Install unloader spring seat, spring saddle, and spring.

4. Install new gasket at air inlet and connect air inlet elbow. Tighten bolts firmly.

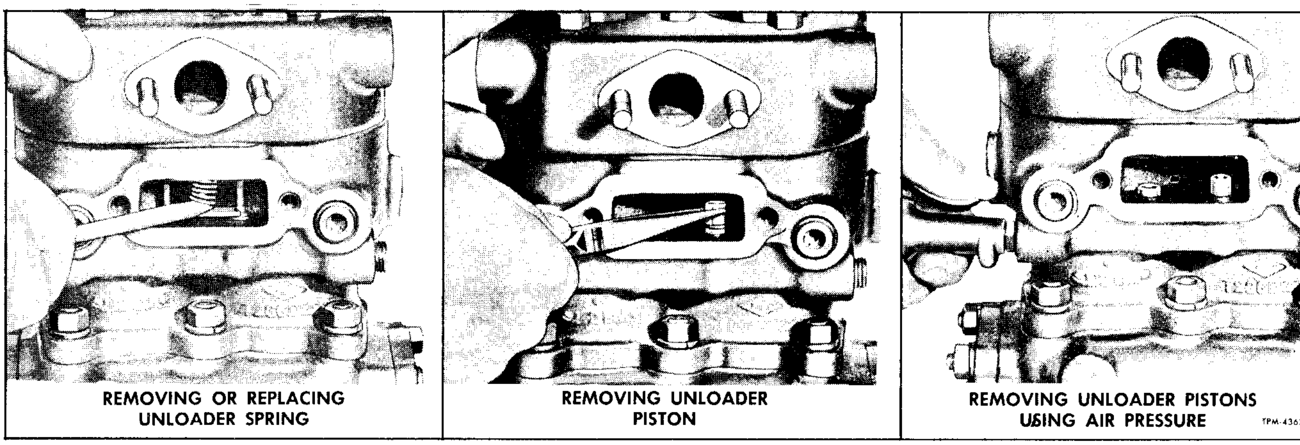


Figure 6—Removing Unloader Components

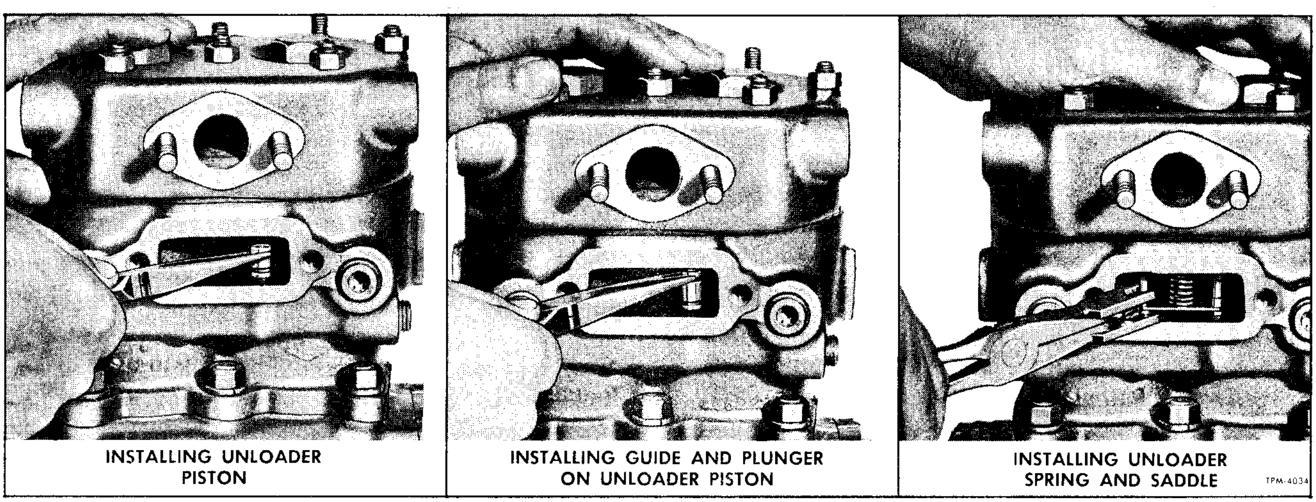


Figure 7—Installing Unloader Components

AIR COMPRESSOR REPLACEMENT

REMOVAL (Fig. 1)

1. Drain engine cooling system.
2. Disconnect water, air, and oil lines from air compressor.
3. Remove nuts and lock washers from four studs attaching air compressor to gear train cover. Pull compressor straight back off studs and remove from vehicle.

INSTALLATION (Fig. 1)

1. Clean oil supply line to compressor, and if possible, run engine a few seconds to be sure oil supply to compressor is flowing freely.
2. Clean oil passage in compressor crankcase.
3. Lubricate compressor cylinder walls and bearings with lubricating oil before placing compressor in position.
4. Clean or replace any damaged or dirty air lines or water lines which may be corroded before connecting them to the compressor.
5. Before installing compressor, examine hub on compressor crankshaft and drive disc on camshaft gear for worn or broken teeth. Check backlash between teeth in hub and teeth on drive coupling, also between teeth in drive disc and teeth on coupling. New limits are 0.000" to 0.001" backlash. If backlash is appreciably greater than this, drive disc or hub (or both) must be replaced.
6. Make sure mating surfaces of air compressor flange and gear train cover are clean. Place new compressor to cover gasket on studs.
7. Insert damper spring in drive coupling and place spring end of drive coupling into hub on compressor crankshaft. Place compressor in position on gear train cover, guiding teeth on coupling into mesh with teeth in drive disc. Install nuts and lock washers on studs and tighten firmly.
8. Connect all water, air, and oil lines, making sure connections are tight.
9. Make sure drain plug is installed in compressor cylinder block, then fill cooling system.

AIR COMPRESSOR OVERHAUL

COMPRESSOR DISASSEMBLY

The crankcase, crankcase bottom cover, cylinder block, and cylinder head are so designed that method of assembly may be varied to meet different installation requirements. These parts should be marked before disassembling, so they can be reassembled in same position.

NOTE: Key numbers in text refer to figure 8.

CYLINDER HEAD REMOVAL AND DISASSEMBLY

1. Remove all cylinder head cap screws (1), then lift off cylinder head assembly (9). Tap head with soft hammer, if necessary, to break gasket joint.
2. Scrape cylinder head and block (16), if necessary, to remove any part of gasket (15) sticking to gasket surface.
3. Remove discharge valve cap nuts (4) and lift out discharge valve springs (3) and discharge valves (2). Remove discharge valve seats (58). Remove inlet valve springs (6) and inlet valves (5) from top of cylinder block.

PISTON AND CONNECTING ROD REMOVAL AND DISASSEMBLY

1. Remove screws (33) and lock washers (32) attaching crankcase bottom cover (31) to crankcase (44), and remove cover and gasket (30).
2. Before removing, mark each piston (49). Marks will be used to reassemble parts in original position. Connecting rods (45) and caps (36) have center punch marks showing proper position of cap on rod.
3. Bend tabs on lock washers up, and remove nuts (34) and washers (35) from connecting rod bolts. Remove connecting rod bearing caps and bearing inserts (37). Do not remove bolts from rods. Push pistons with connecting rods attached out top of cylinder block. Replace caps on rods with inserts in place to prevent damage to bearing inserts.
4. Remove piston rings (48 and 55) from pistons. If connecting rods are to be removed from pistons, remove piston pin lock wires (52), then press piston pins (51) out of pistons and connecting rods.

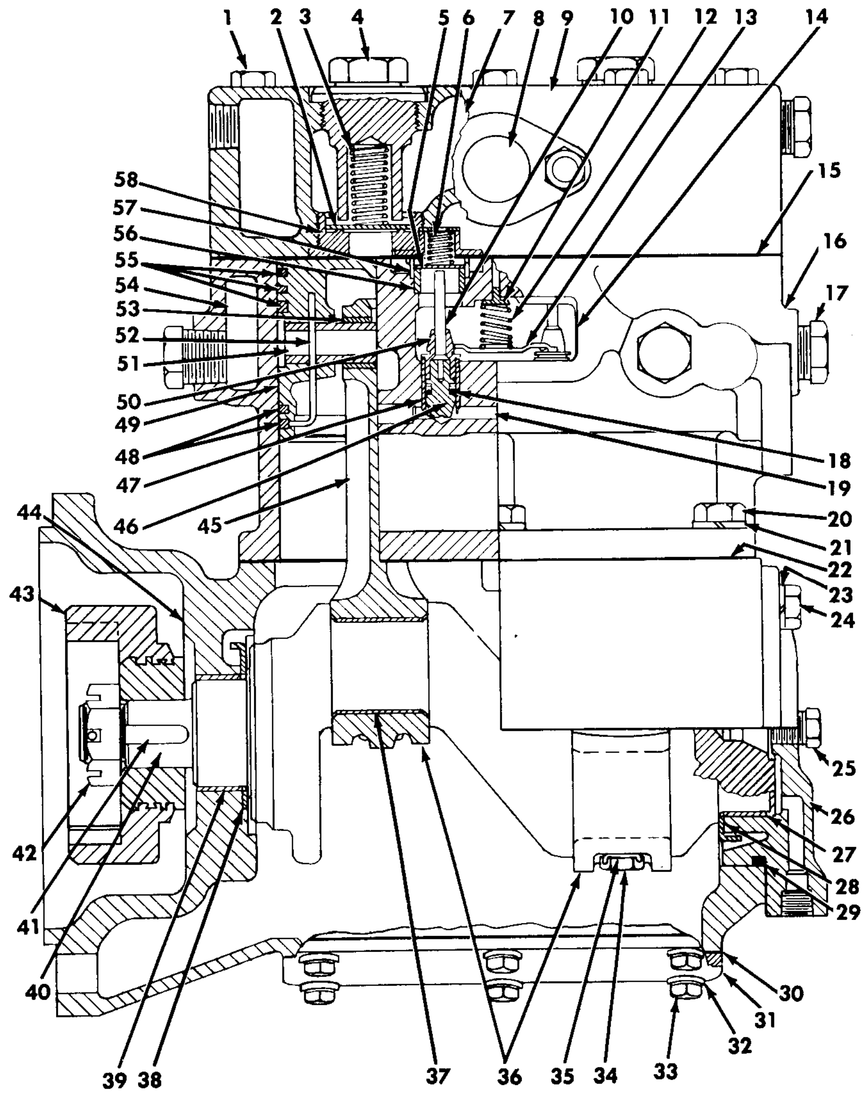
CRANKSHAFT REMOVAL

1. Remove cotter pin and nut (42) from front end of crankshaft (40) and pull drive hub off shaft. Remove drive hub key (41) from keyway in shaft.
2. Remove cap screws (24) attaching rear end cover (26) to crankcase and remove cover and oil seal (29). Remove oil seal from boss on cover.

NOTE

Crankshaft rear bearing (27) will come off with end cover.

3. Remove crankshaft through rear end cover opening.
4. Remove crankcase front (38) and rear (28)



1 Cap Screw
2 Discharge Valve
3 Discharge Valve Spring
4 Discharge Valve Cap Nut
5 Inlet Valve
6 Inlet Valve Spring
7 Water Passage
8 Discharge Port
9 Cylinder Head
10 Unloader Plunger
11 Unloader Spring Seat
12 Unloader Spring
13 Unloader Spring Saddle
14 Air Intake Cavity
15 Gasket
16 Cylinder Block
17 Pipe Plug
18 Grommet
19 Unloader Cavity
20 Cap Screw
21 Lock Washer
22 Gasket
23 Lock Washer
24 Cap Screw
25 Pipe Plug
26 Rear End Cover
27 Crankshaft Rear Bearing
28 Crankshaft Rear Thrust Washer
29 End Cover Oil Seal
30 Gasket
31 Crankcase Cover
32 Lock Washer
33 Cap Screw
34 Nut
35 Lock Washer
36 Connecting Rod Bearing Cap
37 Connecting Rod Bearing
38 Crankshaft Front Thrust Washer
39 Crankshaft Front Bearing
40 Crankshaft
41 Crankshaft Key
42 Crankshaft Nut
43 Drive Hub
44 Crankcase
45 Connecting Rod
46 Unloader Piston
47 Bushing
48 Oil Control Rings
49 Piston
50 Unloader Plunger Guide
51 Piston Pin
52 Piston Pin Lock Wire
53 Connecting Rod Bushing
54 Water Passage
55 Compression Rings
56 Inlet Valve Seat
57 Inlet Valve Guide
58 Discharge Valve Seat

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Figure 8—Air Compressor Assembly

thrust washers. Do not remove crankshaft bearings from crankcase and end cover unless inspection shows necessity for removal.

CYLINDER BLOCK REMOVAL AND DISASSEMBLY

1. Remove bolts and lock washers securing air compressor governor to cylinder block, then remove governor and governor gasket. Discard gasket.

2. Remove cap screws securing cylinder block to crankcase, then remove cylinder block and cylinder block gasket (22). Discard gasket.

3. Remove unloader spring (12) and unloader spring saddle (13).

4. Remove unloader plungers (10), plunger

guides (50), and unloader pistons (46). Remove inlet valve guides (57). NOTE: It may be necessary to use air pressure (with caution) at the governor port of the cylinder block to remove the unloader pistons, after removing the unloader plunger and associated parts.

CLEANING AND INSPECTION OF COMPRESSOR PARTS

CLEANING

1. General. Thoroughly wash all parts in a suitable cleaning solvent to remove all traces of dirt, oil, or grease.

2. Cylinder Head. Soak cylinder head in cleaning solvent to loosen carbon from discharge valve cavities and unloading cavity, and to loosen rust and scale. Blow dirt out of all cavities with compressed air. Scrape carbon and dirt from all surfaces. Scrape gasket particles from gasket surfaces.

3. Discharge Valves. Clean discharge valves, if not worn excessively or damaged, by lapping with crocus cloth held on a flat surface.

4. Oil Passages. Thoroughly clean oil passages through crankshaft, connecting rods, and crankcase rear end cover. If necessary, prod oil passages with a piece of wire; then flush passages with cleaning solvent and blow out with compressed air.

5. Cylinder Block. Soak cylinder block in cleaning solvent to loosen carbon and dirt from air intake cavity. Clean rust and scale from water passages. Blow out all passages with compressed air.

6. Pistons. Scrape all carbon and dirt out of ring grooves in pistons. Clean drain holes in oil ring grooves.

7. Crankcase Bottom Cover. Wash crankcase bottom cover in cleaning solvent.

INSPECTION

1. Cylinder Head. Inspect cylinder head for cracks or breaks. Replace with new head if cracked or damaged.

2. Inlet and Discharge Valve Springs. Discard used inlet and discharge valve springs and replace with new springs.

3. Inlet and Discharge Valves and Seats. Inspect inlet and discharge valves and seats for signs of excessive wear. Replace valves if grooved deeper than 0.003" at point of seat contact. Replace valve seats if condition is such that seats can no longer be refaced.

4. Unloading Pistons and Plungers. Inspect pistons, plungers, and plunger guides for signs of damage or excessive wear. New unloading pistons should slide easily in bores. Check bores for scratches or damage that might increase O-ring wear. Check unloading piston return spring dimension and compare with "Specifications" listed at end of this section. Replace spring if necessary.

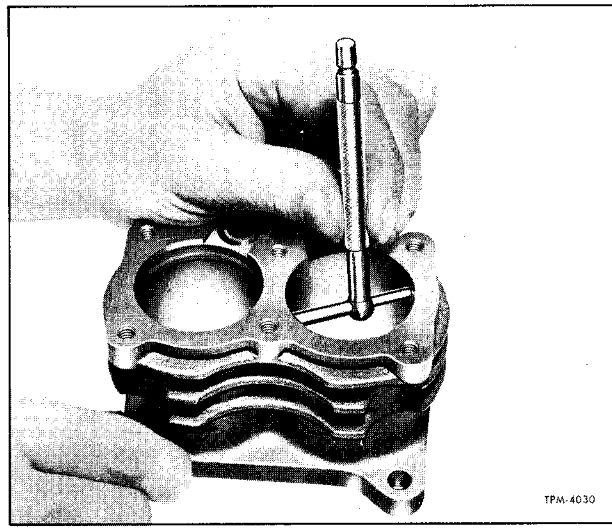


Figure 9—Measuring Cylinder Bore Diameter

5. Crankcase and End Cover. Check crankcase and end cover for cracks or other damage. Replace with new parts if damaged. Check fit of oil seal ring in groove of rear end cover. Ring must be snug fit in groove, and must have 0.008" to 0.015" clearance at gap when placed in end of crankcase.

6. Cylinder Block (Fig. 9). Use telescoping gauge to check bores for out-of-round and taper. Bores which are scored or out-of-round more than 0.002" or tapered more than 0.003" must be rebored, honed, or ground oversize. Pistons and rings 0.010", 0.020", and 0.030" oversize are available. Cylinder bores must be smooth, straight, and round and must be finished with a 500 (or finer) grit hone. The clearance between piston and cylinder wall must not be less than 0.002" or more than 0.004". Replace cylinder block if cracked or damaged.

7. Pistons (Fig. 10). Examine pistons for scoring, cracks, or damage of any kind. Measure outside diameter of piston with a micrometer and compare this measurement with the inside diameter of cylinder bore. Clearance should not be less

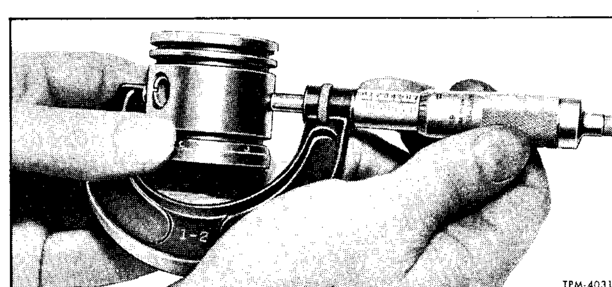


Figure 10—Measuring Piston Diameter

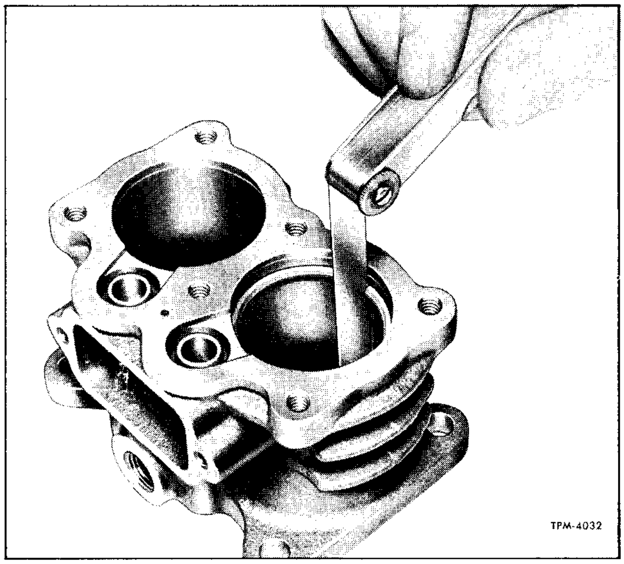


Figure 11—Measuring Piston Ring Gap

than 0.002" or more than 0.004". Piston over 0.004" smaller than cylinder bore must be replaced with an oversize piston.

8. Piston Pins and Bushings. Check fit of piston pins in pistons and connecting rods. Pins must be light press fit in pistons. If piston pin is loose in piston, the pin, piston, or both must be replaced. Check fit of piston pins in connecting rod bushings by rocking pins in bushings. If looseness is evident, replace connecting rod bushings as directed under "Compressor Repair." Discard all piston pin lock wires.

9. Piston Rings (Fig. 11). Check fit of piston rings in ring grooves, and check ring gap with ring in cylinder bore. Clearance between rings and sides of ring grooves should be from 0.0035" to 0.0055" for two wide rings and from 0.002" to 0.004" for three narrow rings as shown in figure 12. Ring gap should be from 0.005" to 0.015".

10. Connecting Rods and Bearings. Check fit of connecting rod bearing inserts on crankshaft journals. Clearance between bearings and crankshaft journals must not be less than 0.002" or more than 0.004". Replace bearing inserts if clearance is excessive or if bearings are cracked or flaked. Connecting rod caps are not interchangeable. Position caps so that locking slots are both located adjacent to same cap screw.

11. Crankshaft. Crankshaft journals should not be out-of-round more than 0.001", ridged, or scored. If grinding is necessary, do not grind fillets at ends of journals. Connecting rod bearing inserts are available in 0.010", 0.020", and 0.030" undersize for reground crankshafts. Check main bearing journals for excessive wear.

12. Crankshaft Bearings. Inspect crankshaft bearings in end cover and crankcase for wear or damage. If necessary, replace bearings as described later under "Compressor Repair."

COMPRESSOR REPAIR

DISCHARGE VALVE AND SEATS

1. Remove slight scratches and pits from discharge valve seats. Use lapping stone, grinding compound, lapping disc, and valve grinding tool.

2. Place discharge valve on valve seats, install discharge valve springs in cap nuts, and thread cap nuts firmly into cylinder head. To test discharge valves for leakage, connect air line to discharge port in cylinder head. Apply 100 pounds air pressure to valves and apply soap suds to discharge valve openings in bottom of cylinder head. Leakage in excess of a one-inch bubble in one second is not permissible. If leakage is excessive, leave air pressure applied. Using a fiber or hardwood dowel and a light hammer, tap valves off seats several times. This should improve fit of valve on seat. Check leakage around top of discharge valve cap nuts by applying soap suds to this area. Leakage must not exceed a one-inch bubble in five seconds. Shut off air pressure and disconnect air line from cylinder head.

3. Remove discharge valve seats too badly worn for refacing. Thread new seats into head and tighten firmly. With new valves, discharge valve travel should be from 0.056" to 0.070".

INLET VALVES AND SEATS

1. Remove slight scratches or pits from inlet valve seats. Use lapping stone, grinding compound, lapping disc, and valve grinding tool. Replace seats that cannot be repaired. Dimension from the top of cylinder block to the inlet valve seat should not exceed 0.145". After installing new seats, the dimension should be 0.101" to 0.113".

2. Inlet valves not badly worn or damaged can be repaired by lapping valves on a piece of crocus cloth held on a flat surface.

CONNECTING ROD BUSHINGS

If piston pin bushings in connecting rods require replacement as previously indicated in step 9 under "Inspection," press old bushings out of connecting rods. Press new bushings in, making sure the oil holes in the bushings line up with the oil passages in the connecting rods. Bushings must then be reamed, honed, or bored to provide 0.0003" -0.0015" clearance on piston pin.

CRANKSHAFT BEARINGS

1. If crankshaft bearings are worn or damaged, use a suitable puller and remove rear bearing from end cover.

2. Use a suitable sleeve and press or drive front bearing out of crankcase.

3. Using a suitable sleeve, press or drive new bearing into rear end cover. Press or drive bearing in flush. Use a suitable sleeve and press or drive new front bearing in crankcase. Press or drive bearing in flush.

COMPRESSOR ASSEMBLY

CRANKSHAFT INSTALLATION

Key numbers in text refer to figure 8.

1. Place front thrust washer (38) on crankshaft (40) with oil groove toward shoulder on shaft.
2. Insert crankshaft through end cover opening in crankcase (44).
3. Position rear thrust washer (28) on crankshaft with oil groove toward shoulder on shaft.
4. Install end cover oil seal (29) in groove of end cover (26).
5. Press end cover and bearing assembly (27) on crankshaft until end cover is against the crankcase.
6. Install cap screws (24) and lock washers (23) attaching end cover to crankcase. Tighten cap screws firmly.
7. Install key (41) in keyway in front end of crankshaft, carefully press drive hub (43) on shaft so bearings and thrust washers will not be damaged, and secure with nut (42) and cotter pin.

CYLINDER BLOCK INSTALLATION

Place new cylinder block gasket (15) on crankcase. Position cylinder block (16) on crankcase, aligning marks made before disassembly. Install cap screws (1) and lock washers. Tighten cap screws firmly.

PISTON AND CONNECTING ROD ASSEMBLY AND INSTALLATION

Key numbers in text refer to figure 13.

1. Position connecting rod (17) in piston (13) and press piston pin (14) into piston with lock wire holes in pin aligned with lock wire holes in piston.
2. Install new piston pin lock wire (15) in piston pin so that long end extends through piston and pin. Snap short end into lock wire hole at bottom of piston skirt.
3. Install piston rings (12) in grooves of pistons. Rings must be installed in proper location and with pip marks upward. Refer to figure 12 for proper clearance dimensions and location of rings. Stagger position of ring gaps outside of inlet throat area.
4. Press bearing inserts (19) into rod and cap (20) by hand, with locking slots in proper alignment (all slots on side of same cap bolt).
5. Lubricate pistons, rings, piston pin bushings, and bearing inserts with clean engine oil.
6. Turn crankshaft to position bearing journal nearest pulley end of crankshaft (No. 1) downward. Remove bearing cap from No. 1 connecting rod

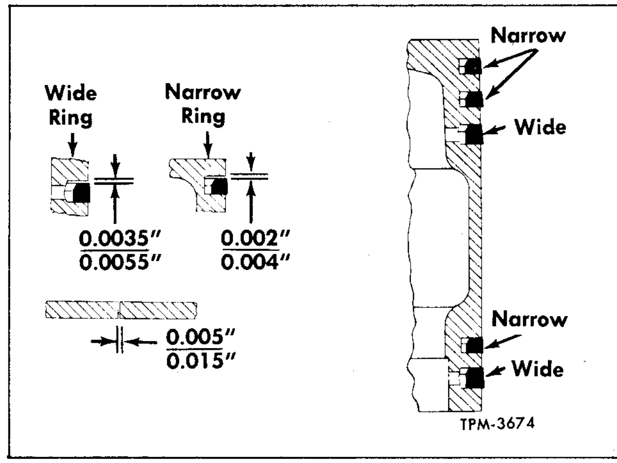


Figure 12—Piston Ring Arrangement and Clearances

leaving connecting rod bolts in rod.

7. Insert No. 1 connecting rod and piston through top of No. 1 cylinder aligning match marks previously installed, and seat squarely on connecting rod bearing journal. Install bearing cap. For proper assembly, two slots in bearing inserts and in rod and cap should be on side of same cap bolt. Install nuts and tighten firmly; then bend lock tabs down on washers.
8. Install No. 2 piston and connecting rod in same manner as described above.
9. Install crankcase bottom cover, using a new gasket, with marks made prior to disassembly aligned. Attach cover to crankcase with screws and lock washers.

UNLOADER PISTON AND PLUNGER ASSEMBLY AND INSTALLATION (Figs. 7 and 8)

1. Coat each unloader piston, O-ring, and piston bore with a silicone type lubricant. Insert piston in bore.
2. Insert plunger in plunger guide. Hold guide and plunger with large-nose pliers and install over unloader piston.
3. Install unloader spring saddle and unloader spring. Make certain that saddle rests squarely on top of plunger guides and make sure top of spring engages spring seat pressed into block.

CYLINDER HEAD ASSEMBLY AND INSTALLATION (Fig. 14)

1. Install discharge valve seats in cylinder head. Place discharge valves on seats through opening in top of cylinder head. Place discharge valve springs in discharge valve cap nuts. Thread cap nuts into cylinder head. Tighten nuts firmly.
2. Place inlet valves (3, fig. 13), inlet valve guides (2, fig. 13), and inlet valve springs (1, fig. 13) in bores in top of cylinder block.
3. Install new cylinder head gasket on cylinder

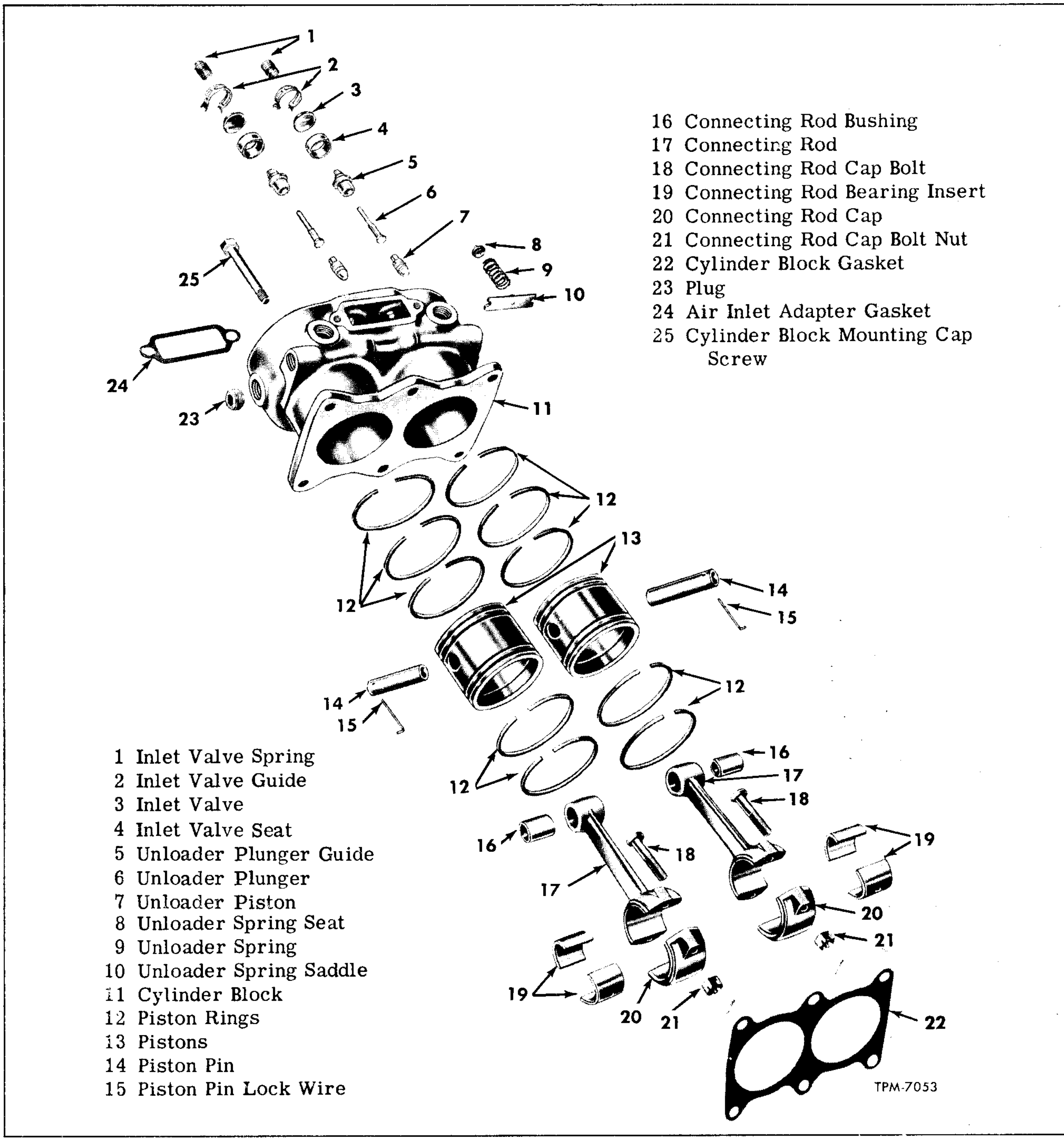


Figure 13—Cylinder Block Components

block. Carefully align inlet valve springs with inlet valve guides in cylinder head. Align marks made before disassembly and install cylinder head on cylinder block. Install cylinder head cap screws and tighten evenly and firmly. Replace all pipe plugs.

4. Install new gasket and replace air inlet elbow.

AIR COMPRESSOR TESTS AFTER OVERHAUL

After overhauling the air compressor, following tests are recommended to determine if compressor is operating properly. Connect an oil supply line having at least 15 pounds pressure to compressor rear end cover opening. Plug other

opening in end cover and in crankcase. Provisions must be made for drainage of oil from crankcase during test. Water must be circulated through compressor water passages while compressor is operating. Figure 15 shows a typical test hook-up which can be used to make the following tests.

RUN-IN TEST

Run compressor for one-half hour at 1750 rpm with compressor discharge port open to atmosphere. Check for oil leaks, overheated bearings, and excessive noise.

OIL PASSING TEST

Run compressor for one-half hour at 1750 rpm, pumping against 50 psi air pressure with an oil trap connected in the discharge line (fig. 15). Close valves 2 and 4, open valve 1, and adjust pressure regulating valve to maintain 50 psi air pressure in the reservoir. Cover air inlet opening in compressor intake cavity with a plate drilled at center to a 3/8" orifice. Drain the oil collector completely before starting test. At end of half hour test, stop motor and open reservoir drain cock to drain air pressure completely. Open the oil collector drain cock to collect and measure oil passed. The oil passed during this test must not exceed 2 cubic centimeters.

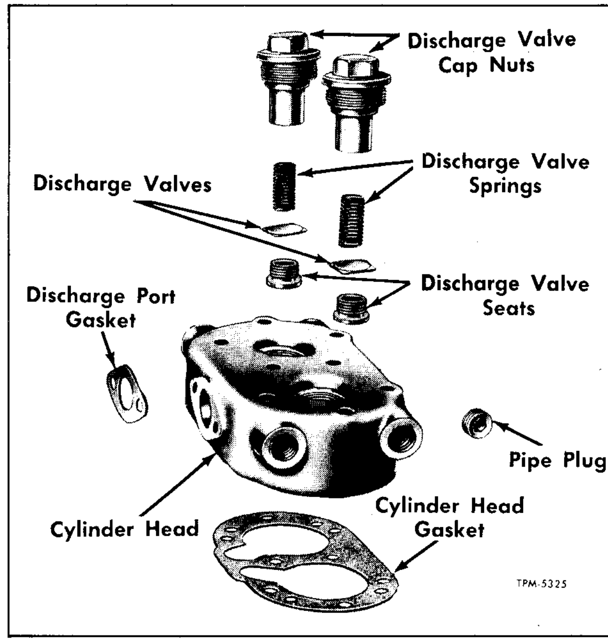


Figure 14—Cylinder Head Components

EFFICIENCY TEST

This test is made by running compressor one-half hour at 1750 rpm connected to a reservoir

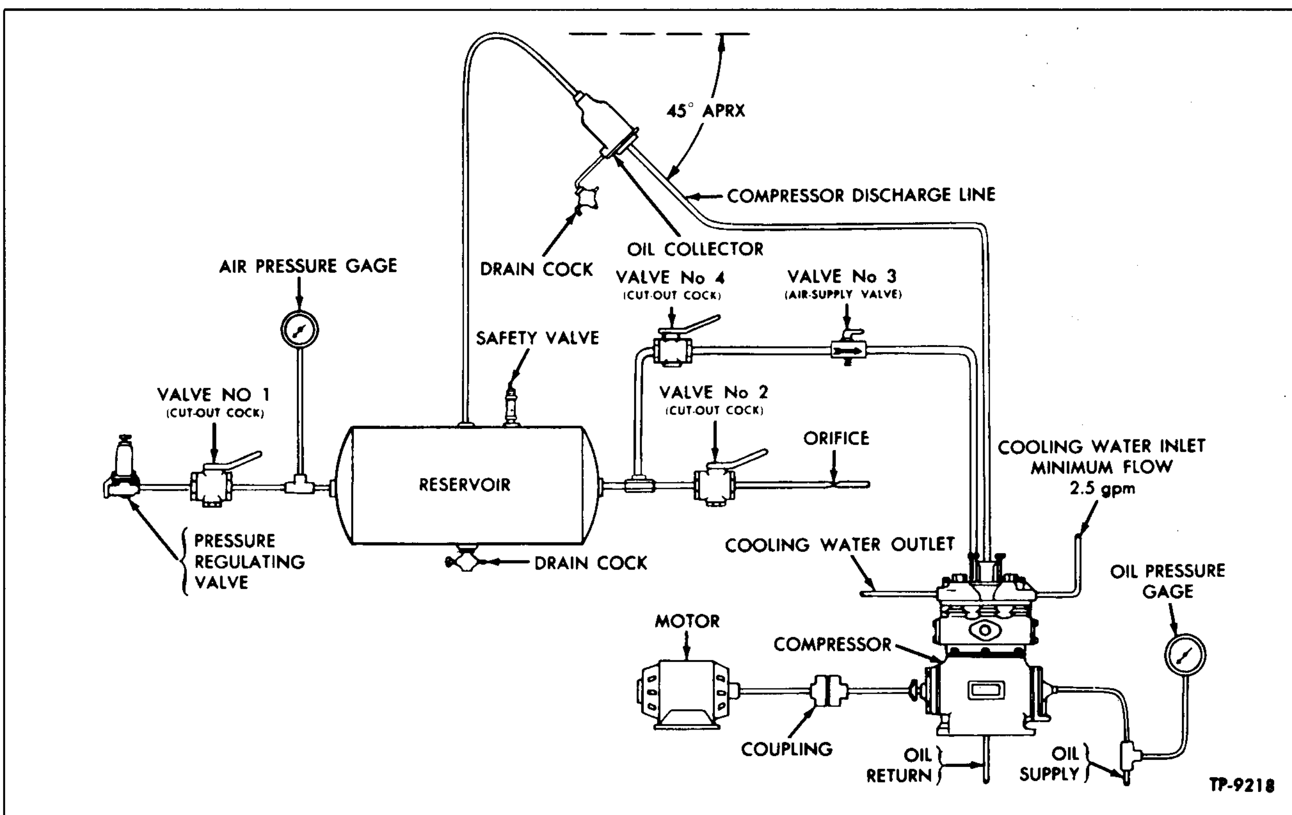


Figure 15—Typical Air Compressor Test Hook-Up

fitted with an orifice type exhaust fitting. Close valves 1 and 4 (fig. 15), open valve 2, and mount orifice in line beyond valve 2. Orifice should be 0.089". With air exhausting continuously through orifice, compressor should maintain 75 psi pressure in reservoir.

This test can also be used on a compressor before it is overhauled to determine the necessity of an overhaul. A compressor which does not maintain 60 pounds pressure in reservoir at 1750 rpm should be overhauled.

UNLOADER PISTON TEST

Unloader piston should be tested by application of 115 psi air pressure through governor line port. When coating unloader pistons with soap suds, leakage should not exceed a 1/2" soap bubble in less than five seconds.

COMPRESSOR UNLOADER MECHANISM TEST

The compressor unloader can be tested by closing valves 1 and 2 and opening valves 3 and 4 (fig. 15). Run compressor until unloader operates. Watch air pressure. Unloader should operate at 115 to 120 psi, stopping further compression.

AIR COMPRESSOR GOVERNOR—TYPE "D-2"

DESCRIPTION

The governor, operating in conjunction with air compressor unloading mechanism, automatically controls air pressure in the air brake or air supply system between the desired, predetermined maximum and minimum pressures. The air compressor runs continually while the engine runs, but actual compression of air is controlled by the governor which stops or starts compression when the maximum or minimum reservoir pressures are reached. The "D-2" governor has a piston upon which air pressure acts to overcome the pressure setting spring and control the inlet and exhaust valve to either admit or exhaust air to or from air compressor unloading mechanism.

Type "D-2" governors can be attached to the air compressor or mounted remotely. They are adaptable to either mounting. Connections in this system are to the reservoir and compressor unloading ports. They also have an exhaust port (fig. 16).

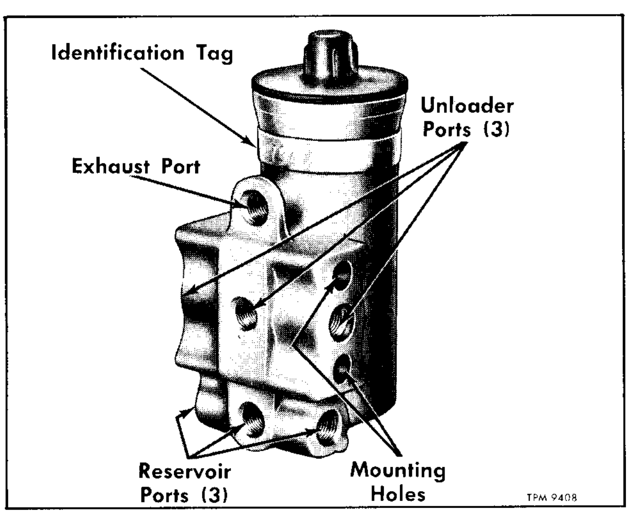


Figure 16—Type "D-2" Governor Ports

OPERATION

(Refer to Figure 17)

Reservoir air pressure enters the D-2 governor at one of its reservoir ports and acts on the area of the piston and beneath the inlet and exhaust valve. As air pressure builds up the piston moves against resistance of the pressure setting spring. The piston and inlet-exhaust valve move up when reservoir air pressure reaches cut-out setting of the governor. The exhaust stem seats on the inlet and exhaust valve and then the inlet passage opens. Reservoir air pressure then flows by the open inlet valve, through the passage to piston and out unloader port to the compressor unloading mechanism. The air, besides flowing to compressor unloading mechanism, also flows around the piston and acts on additional area of the piston. This additive force which results from a larger area on the piston assures a positive action and fully opens

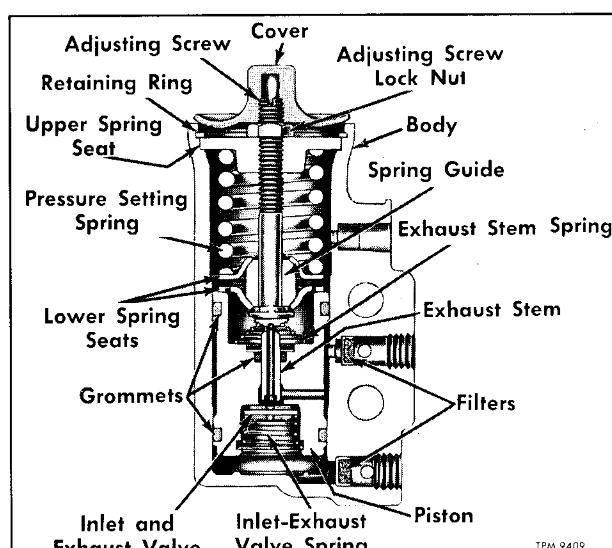


Figure 17—Type "D-2" Air Compressor Governor

the inlet valve.

As the system reservoir air pressure drops to the cut-in setting of the governor, force exerted by the air pressure on the piston will be reduced so that the pressure setting spring will move the piston down. The inlet valve will close and exhaust will open. With exhaust open, air in the unloader line will escape back through the piston, through the exhaust stem and out the exhaust port.

MAINTENANCE

Every 500 operating hours or after every 15,000 miles, clean or replace governor filters (fig. 17). Clean or replace filters as described later in this section under "Type "D-2" Governor Overhaul."

Every 3,000 operating hours or after every 100,000 miles, disassemble the "D-2" governor and clean and inspect all parts. Repair governor as described later in this section under "Type "D-2" Governor Overhaul."

GOVERNOR TESTS

OPERATING TEST (Fig. 17)

Start the engine and build up air pressure in system. Observe reading on air pressure gauge in gauge panel when governor cuts-out, stopping compression of air by the compressor. Reading on gauge when governor cuts-out should be between 115 and 120 psi.

With the engine still running, slowly reduce air pressure in the system by applying and releasing brakes. Observe pressure registered by gauge when governor cuts-in and compression is resumed. Gauge reading when governor cuts-in should be between 100 and 105 psi.

Before condemning or adjusting the governor, be sure the dash air gauge is registering accurately. Use an accurate test gauge to check pressure registered by the dash gauge. If the pressure settings of the Type "D-2" governor are inaccurate or it is necessary that they be changed, adjust governor as described in the following:

ADJUSTMENT

1. Unscrew cover at top of the governor.
2. Loosen adjusting screw lock nut.
3. Using a screwdriver, turn adjusting screw counterclockwise to raise pressure settings. Turn adjusting screw clockwise to lower the pressure settings.
4. When adjustment is completed, tighten adjusting screw lock nut.
5. Install cover on the governor.

LEAKAGE TEST

Leakage checks on the "D-2" governor are made at its exhaust port in both cut-in and cut-out positions. In the cut-in position, check exhaust port for inlet valve leakage by applying a soap solution at the port. Leakage could also be past the bottom piston grommet. In the cut-out position check the exhaust port to determine if leakage is present at the exhaust valve seat or stem grommet. In this position leakage could also be past the upper piston grommet.

Leakage in excess of a 1-inch soap bubble in three seconds is not permissible in either of the above tests. Overhaul governor as described below under "Type "D-2" Governor Overhaul."

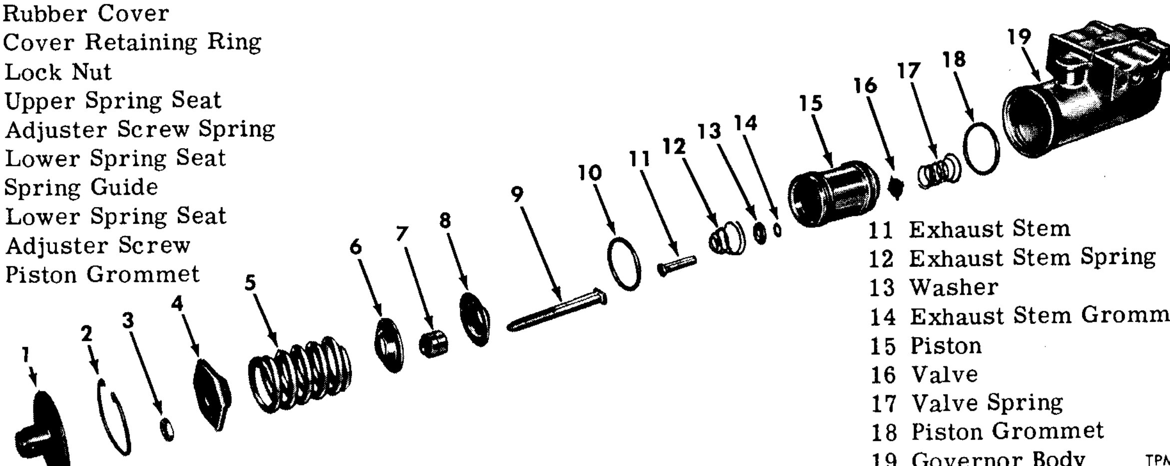
TYPE "D-2" GOVERNOR OVERHAUL

DISASSEMBLY

Key numbers in text refer to figure 18.

1. Using cleaning solvent and a brush, clean

1 Rubber Cover
2 Cover Retaining Ring
3 Lock Nut
4 Upper Spring Seat
5 Adjuster Screw Spring
6 Lower Spring Seat
7 Spring Guide
8 Lower Spring Seat
9 Adjuster Screw
10 Piston Grommet



11 Exhaust Stem
12 Exhaust Stem Spring
13 Washer
14 Exhaust Stem Grommet
15 Piston
16 Valve
17 Valve Spring
18 Piston Grommet
19 Governor Body

TPM-9398

Figure 18—Type "D-2" Governor Components

dirt and grease from exterior of governor.

2. Using fingers, remove rubber cover (1) from governor assembly. Remove two pipe plugs from governor body (19).

3. Using Tru-Arc pliers, remove cover retaining ring (2) from groove in governor body.

4. Remove adjusting screw and spring assembly from governor body.

5. Remove the piston assembly from governor body. It may be necessary to tap governor body flat against work bench to dislodge piston.

6. Remove two piston grommets (10 and 18) from grooves in piston (15). Discard grommets.

7. Remove valve spring (17), valve (16), exhaust stem (11), and exhaust stem spring (12) from piston.

8. Remove exhaust stem grommet (14) and washer (13) from bore. Discard grommet.

9. Mount adjusting screw and spring assembly in a vise with soft jaws.

10. Carefully measure distance lock nut (3) is threaded on adjuster screw (9) before removing it in step 11 following:

11. Remove lock nut from adjuster screw; then thread adjuster screw out of upper spring seat (4).

12. Remove spring (5), lower spring seat (6), spring guide (7), and second lower spring seat (8) from adjuster screw.

CLEANING AND INSPECTION

1. Wash all metal parts in cleaning solvent. Blow parts dry. Wipe rubber parts dry.

2. Check valve spring (17), exhaust stem spring (12), and adjuster screw spring (5) for free length, compressed length, distortion, or collapsed coils. See "Specifications" at end of this section.

3. Inspect governor body (19) for cracks, nicks, burrs, or other damage. Check for crossed or stripped threads.

4. Inspect adjuster screw (9) for crossed or stripped threads and distortion.

5. Examine the piston (15) for nicks, burrs, or other damage.

6. Check governor valve (16) for deterioration or other damage.

7. Examine the two filters in governor body. If damaged, use a sharp hooked tool and remove them. Use a suitable sleeve and press new filters in governor body ports.

8. Inspect all air passages in ports for obstructions.

ASSEMBLY

Key numbers in text refer to figure 18.

Prior to assembly of governor, lubricate governor body bore, top of piston, piston grooves, piston grommets, spring guide, and adjusting screw with lubricant. Refer to "Specifications" at end of "SERVICE AIR BRAKE SYSTEM" section of this group for description of lubricant.

1. Position first lower spring seat (8), spring guide (7), second lower spring seat (6), and spring (5) on adjuster screw (9).

2. Thread adjuster screw into upper spring seat (4); then mount adjuster screw and spring assembly in a vise having soft jaws.

3. Install lock nut (3) on adjuster screw. Turn nut on screw the same distance measured at disassembly.

4. Position new exhaust stem grommet (14) in groove inside piston (15). Install new washer (13) in piston. Prick punch washer in four places.

5. Install two new grommets (10 and 18) in grooves on outside of piston.

6. Position exhaust stem spring (12), exhaust stem (11), valve (16), and valve spring (17) in piston.

7. Insert piston assembly in bore of governor body.

8. Position adjusting screw and spring assembly in governor body; then using Tru-Arc pliers install the retaining ring (2).

9. Install new rubber cover (1) on governor body (19) over adjusting screw.

10. If previously removed, install two pipe plugs in governor body.

11. After the governor is installed in the vehicle, make "Governor Tests" described previously.

Refer to next page for "Specifications."

SPECIFICATIONS

AIR COMPRESSOR

MAKE .... Bendix-Westinghouse

MODEL .... Tu-Flo 500

TYPE .... 2 Cylinder, Water Cooled, Engine Oil Lubricated, and Flange Mounted

CAPACITY (AT 1250 RPM) .... 12 Cu. Ft.

CYLINDER BLOCK BORE .... 2.5005″

INLET VALVE SEAT WORN GROOVE
- Not to Exceed .... 0.003″

DISCHARGE VALVE SEAT WORN GROOVE
- Not to Exceed .... 0.003″

PISTON RING GAP (IN CYLINDER) .... 0.005″-0.015″

PISTON RING CLEARANCE (IN GROOVE)
- Narrow Ring .... 0.002″-0.004″
- Wide Ring .... 0.0035″-0.0055″

CLEARANCE BETWEEN PISTON AND CYLINDER WALL .... 0.002″-0.004″

PISTON
- Length .... 2 11/32″
- Number Ring Grooves 5
- Width of Ring Grooves .... 0.0955″-0.0965″
- Diameter at Top .... 2.484″-2.488″
- Diameter at Ring Groove .... 2.223″
- Diameter at Ring Land .... 2.487″-2.491″

WRIST PIN
- Length .... 2 5/16″
- Inside Diameter .... 5/16″
- Outside Diameter .... 0.4375″-0.4377″

BUSHINGS
- Cylinder Block Bushing
  - Outside Diameter .... 0.473″-0.474″
  - Inside Diameter .... 0.376″-0.378″
  - Width .... 0.690″-0.693″
- Wrist Pin Bushing
  - Outside Diameter .... 0.6570″-0.6575″
  - Inside Diameter .... 0.508″-0.510″
  - Width .... 0.845″

CRANKSHAFT BUSHINGS
- Front
  - Outside Diameter .... 1.5040″-1.5055″
  - Inside Diameter .... 1.3802″-1.3812″
  - Width .... 0.521″-0.541″
- Rear
  - Outside Diameter .... 2.2980″-2.2995″
  - Inside Diameter .... 2.1679″-2.1689″
  - Width .... 0.552″-0.572″

CRANKSHAFT
- Front Bearing Journal Diameter .... 1.3779″-1.3783″
- Connecting Rod Journal Diameter .... 1.1242″-1.1250″
- Rear Bearing Journal Diameter .... 2.1653″-2.1658″
- Length .... 8 47/64″

CONNECTING ROD BEARING INSERT
- Width .... 1.235″-1.250″
- Wall Thickness—Standard .... 0.05185″-0.05210″
  - 0.010″ Undersize .... 0.05685″-0.05710″
  - 0.020″ Undersize .... 0.06185″-0.06210″
  - 0.030″ Undersize .... 0.06685″-0.06710″
- Length .... 0.924″

CRANKSHAFT THRUST WASHER
- Front
  - Inside Diameter .... 1.476″
  - Outside Diameter .... 1.976″
  - Thickness .... 0.061″-0.063″
- Rear
  - Inside Diameter .... 2.263″
  - Outside Diameter .... 2.763″
  - Thickness .... 0.061″-0.063″

SPRINGS
- Unloader Spring
  - Free Length .... 3/4″
  - Solid Length .... 5/16″
  - No. of Active Coils 5
- Discharge Valve Spring
  - Free Length .... 1 7/64″
  - Solid Length .... 13/16″
  - No. of Active Coils 13
- Inlet Valve Spring
  - Free Length .... 29/64″
  - Solid Length .... 13/64″
  - No. of Active Coils 6

GOVERNOR

MAKE .... Bendix-Westinghouse

MODEL .... "D-2"

CUT-OUT PRESSURE .... 115-120 PSI

CUT-IN PRESSURE .... 100-105 PSI

SPRINGS
- Valve Spring
  - Free Length .... 53/64″
  - Solid Length .... 5/32″
  - No. of Active Coils 4
- Exhaust Stem Spring
  - Free Length .... 19/32″
  - Solid Length .... 3/64″
  - No. of Active Coils 3
- Adjuster Screw Spring
  - Free Length .... 1 23/32″
  - Solid Length .... 1 1/64″
  - No. of Active Coils 4 1/2

Proper preventive maintenance on a regular daily, monthly and yearly basis will help eliminate "on-the-road" failures. Follow recommended procedures covering testing, inspection and adjustment for best results.

Clutch and Controls

DESCRIPTION AND OPERATION

CLUTCH

Clutch (fig. 3) is a single-speed, three-plate, wet disc type, with manually controlled disengagement and engagement by foot-operated pedal and linkage (figs. 1 and 2). Clutch driven disc assemblies are splined to a drive flange, which in turn is splined to transmission pinion shaft. Two facings are bonded to each driven disc, which are held tightly between friction surfaces of spacer plate, pressure plate, and flywheel by a diaphragm spring when clutch is engaged.

CLUTCH CONTROLS

Clutch is manually controlled by foot-operated clutch pedal, linkage, rods, and levers as illustrated in figures 1 and 2. Pedal cross shaft is mounted in self-aligning bearings. Control rods are enclosed within a loom and extend rearward through cross members under coach floor to engine compartment bulkhead. Intermediate levers (fig. 1) are used to raise linkage from lower floor level to upper floor level. Rear end of intermediate control rod is connected to a bellcrank at engine compartment bulkhead. A transverse control rod connects bellcrank at engine compartment to clutch release lever. Wedge on rear control rod is held in contact with release lever by a spring and collar. Linkage adjustments are provided by adjustable yokes at ends of control rods, while clutch release bearing clearance adjustment is accomplished by an adjusting nut on rear control rod at upper end of clutch release lever.

FLUID SYSTEM

The clutch and transmission are pressure lubricated by fluid pump, mounted inside clutch housing and driven by gear from clutch release mechanism. Fluid is picked up from transmission sump pan by the pump and delivered by tube to oil filter, pressure regulator valve, and to passage in clutch housing. Fluid still under pressure is delivered to clutch parts from drilled passages in drive pinion shaft, also to transmission main drive shaft and mainshaft.

A disposable type oil filter is mounted on transmission. Oil pressure is controlled by a pressure regulator valve in filter adapter. A low oil pressure sending alarm switch is located in filter mounting base. Refer to TRANSMISSION (SEC. 17) for additional lubrication information and for overhaul procedure on fluid pump.

CLUTCH CONTROL ADJUSTMENTS

AT FRONT END

Key numbers in text refer to figure 1.

1. Check distance from pedal lever (3) to underside of floor. Distance should be 4-1/2 inches at point indicated in figure 1.

2. If necessary to change position of pedal lever in relation to floor, first check return spring (10) which must be in good condition, and check to see that adjustable collar (2) is held firmly against floor. Loosen set screw in collar (2) and move collar as required to provide 4-1/2-inch dimension from pedal lever to floor. Tighten set screw.

3. With clutch pedal up, measure distance from center of clevis pin at lower idler lever (12) to bulkhead.

4. If necessary loosen lock nut on rod (11), remove clevis pin, and adjust yoke (13) to provide the 1-5/64-inch dimension shown in figure 1.

5. After completion of above step, measure distance from center of clevis pin at upper idler lever (15) to bulkhead. If required, loosen lock nut on rod (14), remove clevis pin, and adjust yoke to provide the 9/32-inch dimension shown in inset in figure 1.

AT REAR END

Key numbers in text refer to figure 2.

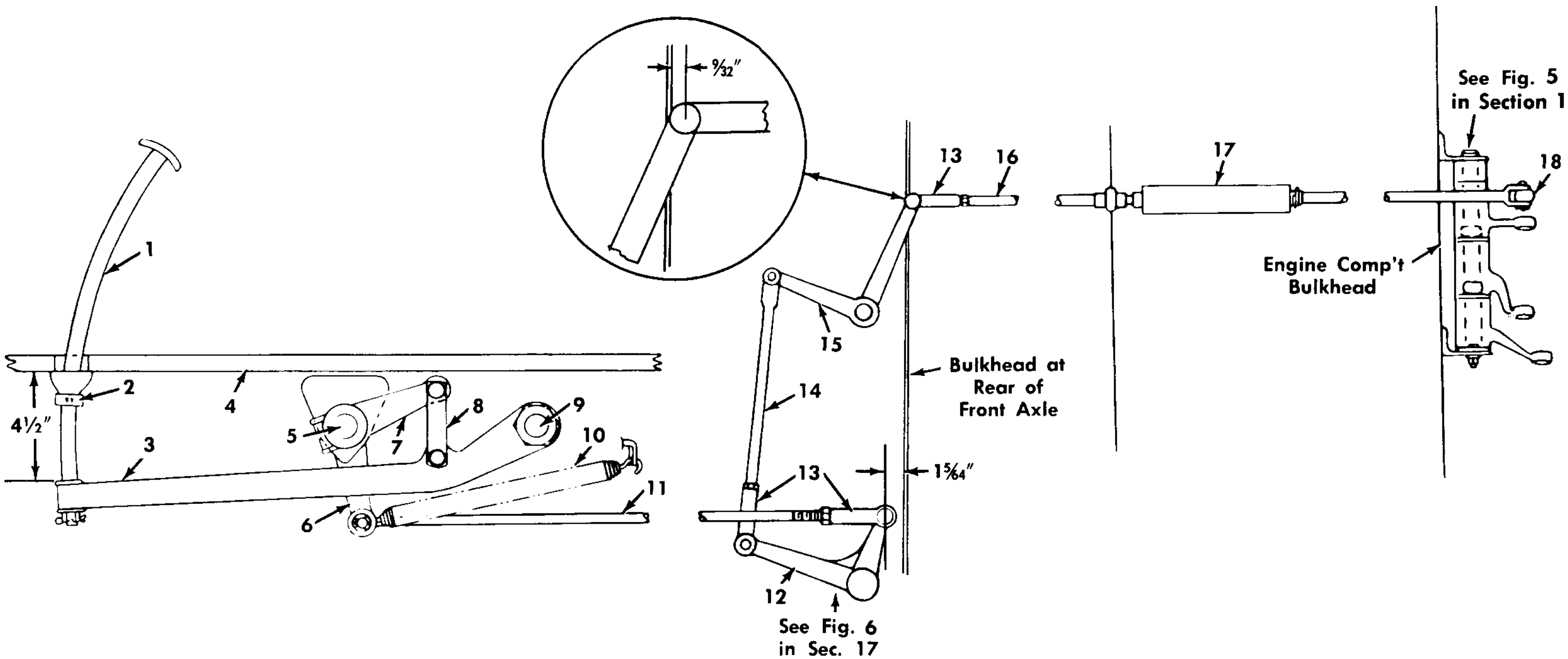
For proper leverage and satisfactory clutch linkage operation, the distance from center of clevis pin in bellcrank (1) to rear face of engine compartment bulkhead (3) is 4.32 inches as shown in figure 2.

1. With clutch pedal up and front end adjusted, measure distance from center of clevis pin in bellcrank (1) to bulkhead (3).

2. If necessary, loosen lock nut on intermediate control rod (2), remove clevis pin, and adjust yoke to provide the 4.32 inch dimension required.

ADJUSTMENT FOR NORMAL WEAR
(IN ENGINE COMPARTMENT)

As normal wear occurs at clutch facings, it may become necessary to make the adjustment



1 Clutch Pedal
2 Adjustable Collar
3 Pedal Lever
4 Floor
5 Clutch Control Cross Shaft
6 Cross Shaft Inner Lever
7 Cross Shaft Outer Lever
8 Link
9 Pedal Lever Shaft
10 Return Spring
11 Front Control Rod
12 Lower Idler Lever
13 Adjustable Yoke
14 Vertical Control Rod
15 Upper Idler Lever
16 Intermediate Control Rod
17 Bellows
18 Bellcrank

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Figure 1—Clutch Control Linkage—Pedal To Engine Bulkhead

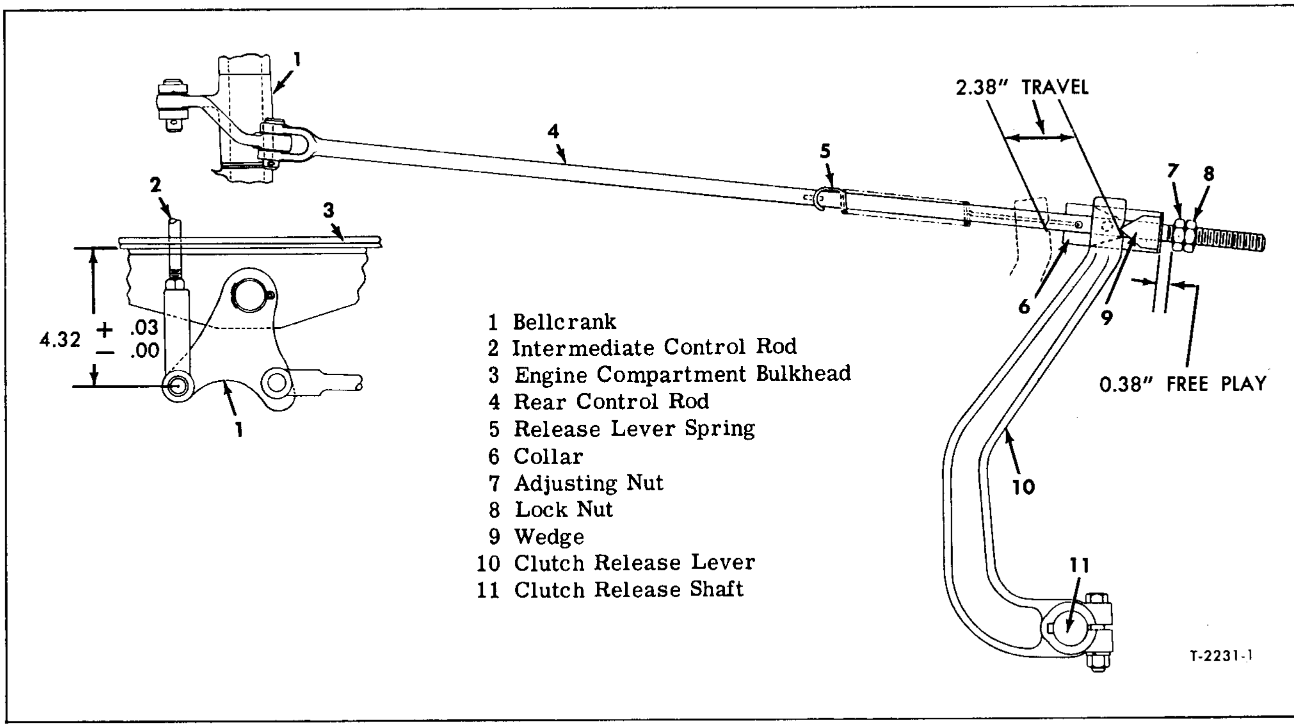


Figure 2—Clutch Control Linkage—Engine Bulkhead To Transmission

described below to provide clearance at clutch release bearing and insure proper clutch action.

Key numbers in text refer to figure 2.

1. If, when checking free movement at clutch release lever (10), it is found that there is less than 0.12-inch of lever free movement when lever is pulled toward adjusting nut, adjustment at nut (7) is necessary.

2. Loosen lock nut (8) to permit turning of adjusting nut (7).

3. Proper linkage adjustment provides for a clearance of 0.38-inch between wedge collar (6) and adjusting nut (7).

4. Lock the adjusting nut (7) with lock nut (8).

5. Start engine and check to determine that clutch release can be obtained. If not, the trouble lies in the main clutch area and not the clutch linkage adjustment. This may occur when clutches are excessively worn or when there is interference of some kind in the clutch area.

NOTE: The feel of clutch pedal when engaging or releasing clutch is somewhat different from the feel with conventional clutches. This is normal and does not indicate improper clutch operation.

6. Finally try pulling lever (10) toward adjusting nut (7) and note the distance lever can be moved freely. There should be at least 0.38-inch of free movement; if lever cannot be moved freely, damage to internal release mechanism is indicated.

CLUTCH OVERHAUL

(Key Numbers in Text Refer to Figure 3)

1. Remove transmission assembly as instructed in TRANSMISSION (SEC. 17) in this manual.
2. Remove spring (37) and washer (36) from inside drive flange.
3. Remove retaining ring (3) from drive pinion shaft, then remove release bearing adapter (20) and washer (17).

REMOVAL OF CLUTCH PLATES

1. Loosen twelve cap screws (27) alternately and evenly until tension is removed from diaphragm spring (9). Remove cover plate (28) and diaphragm spring (9) with release mechanism.
2. Remove retaining ring (31) and retaining

CLUTCH AND CONTROLS

1 Crankshaft
2 Oil Seal
3 Retaining Ring
4 Flywheel Housing
5 Flywheel
6 Spacer Plate w/Springs
7 Gasket
8 Driven Plate w/Facings
9 Diaphragm Spring
10 Release Yoke
11 Thrust Ring
12 Plug
13 Spring
14 Oil Transfer Tube
15 Bearing Race
16 Oil Transfer Flange
17 Washer
18 Drive Pinion Shaft
19 Oil Seal Ring
20 Release Bearing Adapter
21 Release Bearing
22 Oil Pump Drive Gear
23 Clutch Housing
24 Oil Pump Assembly
25 Pump Driven Gear
26 Pressure Plate
27 Cap Screw
28 Cover Plate
29 Cap Screw
30 Retaining Washer
31 Retaining Ring
32 Drive Flange
33 Bushing
34 Restricted Fitting
35 Retaining Ring
36 Washer
37 Spring

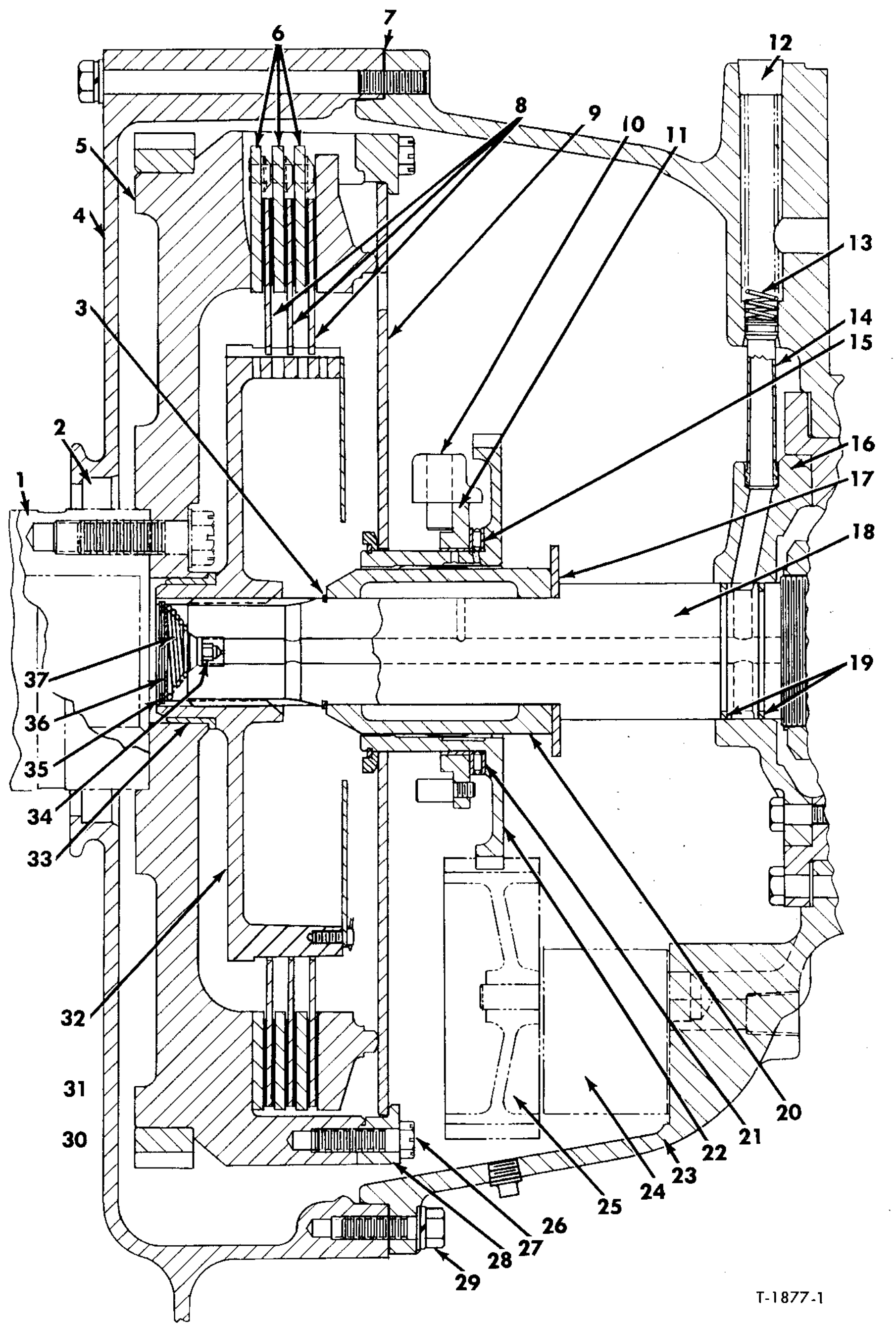


Figure 3—Sectional View of Clutch Assembly

washer (30) from pump drive gear. Remove diaphragm spring.

3. Remove thrust ring (11), bearing races (15), and release bearing (21) from gear.

4. Remove pressure plate (26), three driven plates with facings (8), and three spacer plates with springs (6) from flywheel and drive flange.

5. Remove drive flange (32) from crankshaft.

CLEANING AND INSPECTION

CLEANING

Clean all clutch components and clutch release parts before inspecting for wear or damage. Clutch drive facings should not be immersed in cleaning solvent, but other parts should be cleaned by soaking to dissolve all accumulated oil and foreign matter. Clean the clutch disc facings by wiping with a clean cloth dampened with cleaning solvent.

INSPECTION

Before deciding to reinstall clutch parts, carefully inspect them for wear, fractures, and other damage.

Key numbers in text refer to figure 3.

Clutch Spring and Cover Plate

Carefully inspect clutch diaphragm spring (9) for evidence of worn, cracked, or broken fingers. Inspect outer edge of spring for fractures and for warpage.

Inspect clutch cover plate (28) and bolts (27) for damaged threads.

Pressure Plate and Spacer Plates

Inspect surfaces on spacer plates (6) and pressure plate (26) which are contacted by driven plate facings. If surfaces are scored or worn or if any warpage of either plate is noted, new parts should be obtained for use in assembling clutch. Do not reface pressure or spacer plates.

Inspect the springs riveted to spacer plates (6). Outer ends of springs should all be 0.300 inch from surface of spacer plate (6). If necessary, carefully bend springs to obtain this dimension. If any of the springs are broken or excessively worn, remove rivets and install new springs. After installing springs, make sure free ends are all the same height (0.300") above surface of spacer plate.

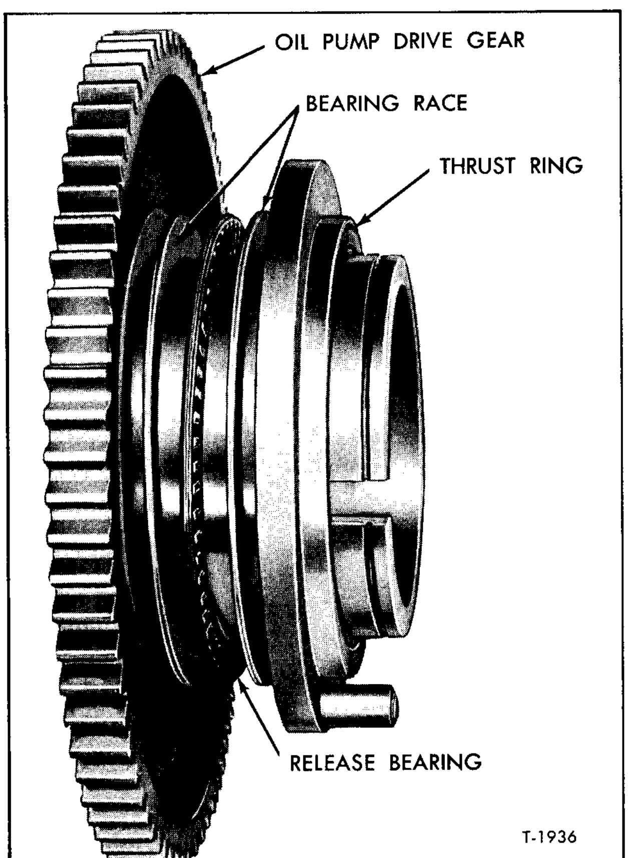


Figure 5—Oil Pump Drive Gear Assembled To Clutch Diaphragm Spring

Clutch Driven Plate

Inspect facings on driven plates for wear. If wear has reduced thickness appreciably, install new members. Facings should be inspected for metal particles imbedded in surfaces which mate with driving members.

Facings at each side of disc must be flat within 0.017 inch total indicator reading.

Drive Flange

Inspect teeth or splines on drive flange (32) which engage driven discs, and inspect internal splines at hub which mate with transmission drive pinion. If wear is excessive the drive flange assembly should be replaced.

Also inspect surface of drive flange hub which contacts flywheel bushing (33). Surface should not be scored or worn.

Make sure retaining ring (35) is in place in groove in drive flange.

Flywheel Assembly

Inspect bushing (33) installed in bore at center of flywheel. Replace bushing if worn or scored. Bushing original I.D. is 2.188 to 2.189 inches when installed. Inspect for wear where drive spacer plate lugs contact flywheel drive slots.

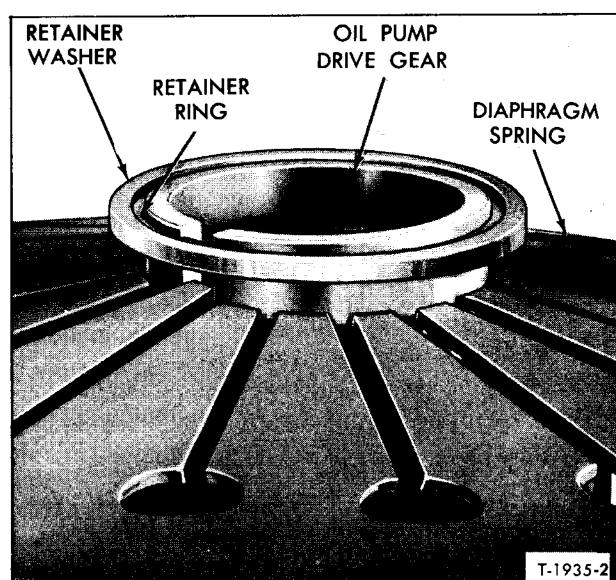


Figure 4—Clutch Release Bearing and Thrust Ring Assembled on Oil Pump Drive Gear

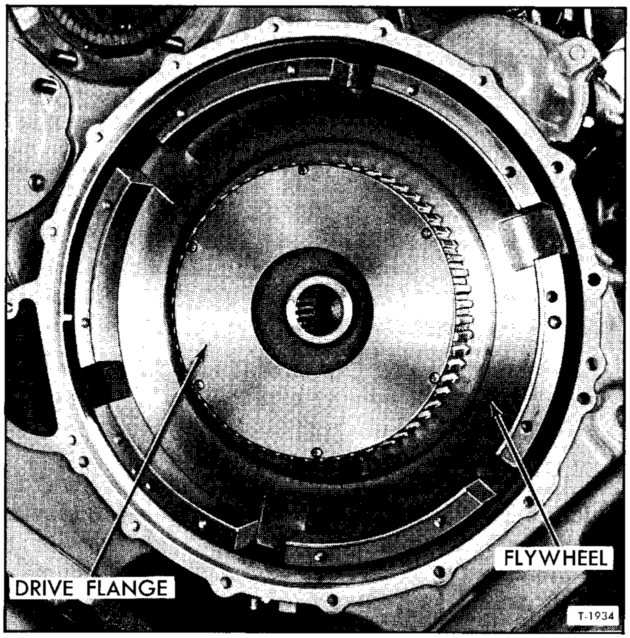


Figure 6—Clutch Drive Flange Installed

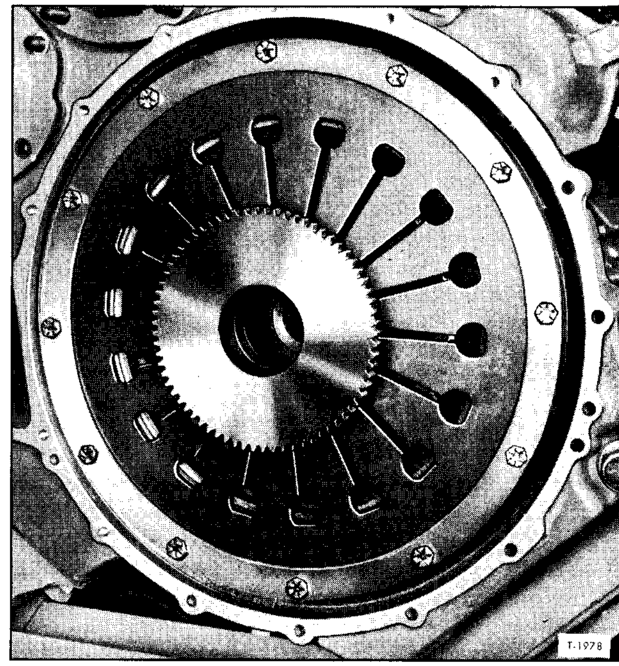


Figure 7—Clutch Cover Plate, Diaphragm Spring, and Oil Pump Drive Gear Installed

Clutch Release Mechanism

Inspect clutch release bearing (21) and bearing races (15) for wear and replace if inspection indicates necessity.

Inspect clutch release thrust ring (11) for wear at bushing and replace if excessive wear or other damage is indicated.

Inspect oil pump drive gear (22) for wear at surface contacted by thrust ring. Inspect gear teeth for damage. Replace if worn or damaged.

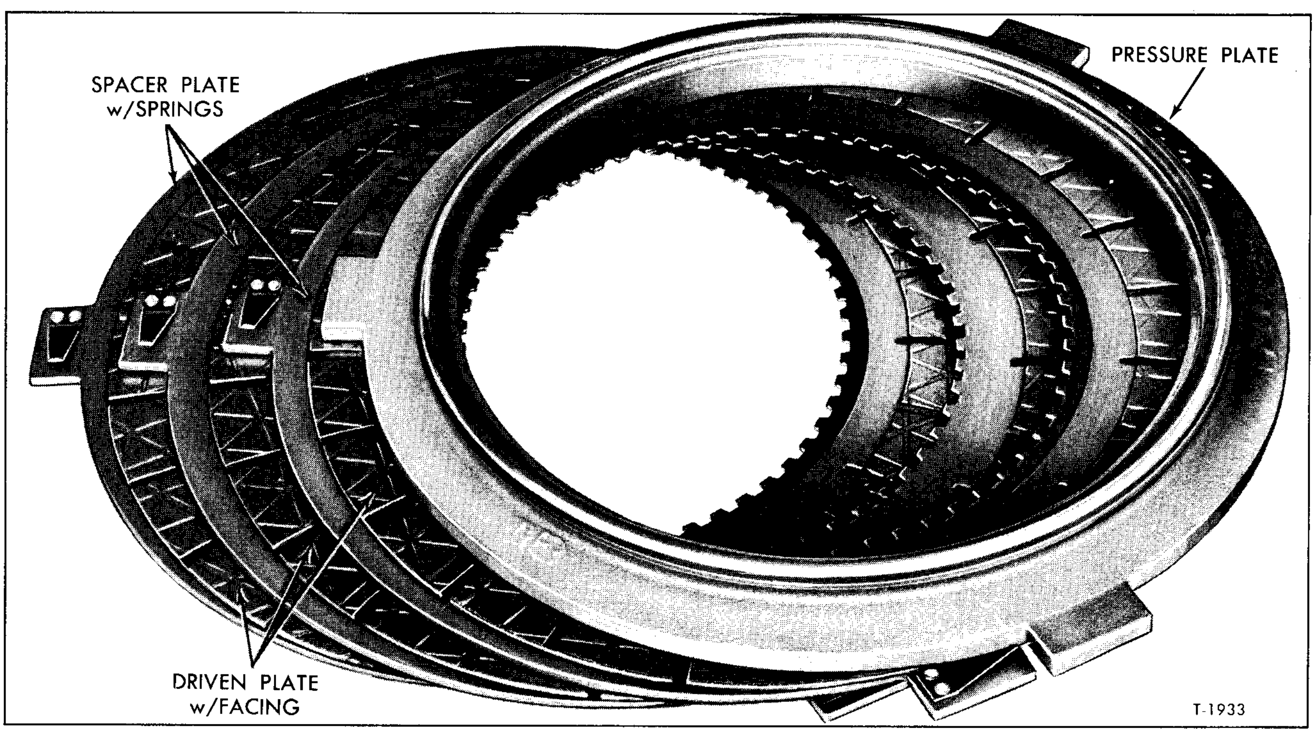


Figure 8—Spacer Plates, Driven Plates, and Pressure Plate Assembly Sequence

ASSEMBLY OF RELEASE MECHANISM

Key numbers in text refer to figure 3.

1. Install release bearing inner race (15), release bearing (21), and release bearing outer race (15) on hub of oil pump gear as illustrated in figure 4.
2. Install thrust ring assembly in hub of oil pump drive gear with pin pointing away from gear (fig. 4). Apply lubricant to release mechanism to provide lubrication initially.
3. Install hub of oil pump drive gear through diaphragm spring (fig. 5) with long finger of spring in gear hub slot.
4. Install retaining washer with spherical edge toward diaphragm spring and secure with retaining ring (fig. 5).

CLUTCH PLATES INSTALLATION

Immerse driven plate and facing assemblies, also spacer plates, in S.A.E. 30 engine oil before assembly. Lubricate all other parts during assembly operations. Key numbers in following text refer to figure 3.

1. Install drive flange (32) hub in flywheel bushing as illustrated in figure 6.
2. Refer to figure 8 and install spacer plate (6), and driven plate with facings (8) until three each are assembled over drive flange (32) and into flywheel. NOTE: Leaf springs on spacer plates are toward transmission as illustrated in figure 3.
4. Install pressure plate (26) in flywheel and against driven plate facings (8).
5. Install previously assembled diaphragm spring (9) and release mechanism with cover plate (28) to flywheel and secure with twelve cap screws (27) as illustrated in figure 7. Tighten cap screws evenly and alternately to torque specified at end of this section.

NOTE: Diaphragm spring should be installed with long finger toward right side of engine as shown in figure 13 in TRANSMISSION (SEC. 17).

6. Place washer (36) and spring (37) in drive flange, then install transmission as instructed in TRANSMISSION (SEC. 17) of this manual.

> NOTE: Refer to TRANSMISSION (SEC. 17) for clutch control intermediate idler lever replacement.

SPECIFICATIONS

CLUTCH SPACER PLATE	
Thickness	0.185″-0.189″
Flat Within	0.015″ T.I.R.
Surfaces Parallel Within	0.002″ T.I.R.
Width of Lugs	1.742″-1.744″
CLUTCH PRESSURE PLATE	
Thickness	1.040″-1.045″
Flat Within	0.006″ T.I.R.
Width of Lugs	1.742″-1.744″
CLUTCH DRIVE FLANGE	
Hub Diameter at Flywheel Bushing	2.183″-2.185″
FLYWHEEL	
Bushing Inside Diameter	2.188″-2.189″
Drive Slot Width	1.750″-1.752″
CLUTCH PLATE AND FACING	
Thickness	0.167″-0.173″
Flat Within	0.017″ T.I.R.
PUMP DRIVE GEAR	
Bushing I.D.	2.755″-2.757″
RELEASE THRUST RING	
Bushing I.D.	3.341″-3.339″
RELEASE BEARING RACE	
Thickness	0.060″-0.063″
TORQUE SPECIFICATIONS	
Cover Plate to Flywheel Bolt	30-35 ft.-lbs.

Keep clutch control linkage
properly adjusted and lubricated.

Cooling System

DESCRIPTION

Engine is cooled by liquid which is circulated within a sealed system. Cooling system units include: water pump, radiator, surge tank and engine thermostats. A fan mounted on machined fan and accessory drive at front of engine forces air through radiator core for cooling. As special equipment, radiator may be equipped with shutters.

Pressure valve at surge tank is used to maintain pressure within cooling system. Temperature of coolant within engine is controlled by engine thermostats in thermostat housing at front of engine. Cooling system is filled through filler cap at surge tank (fig. 1).

Water for heating coach is supplied from the engine cooling system. Refer to HEATING AND AIR CONDITIONING (SEC. 26) of this manual.

An alarm buzzer and tell-tale warning light at instrument panel warns the driver in case engine becomes overheated. In addition, a temperature gauge on instrument panel is operated from electrical sending unit installed on engine.

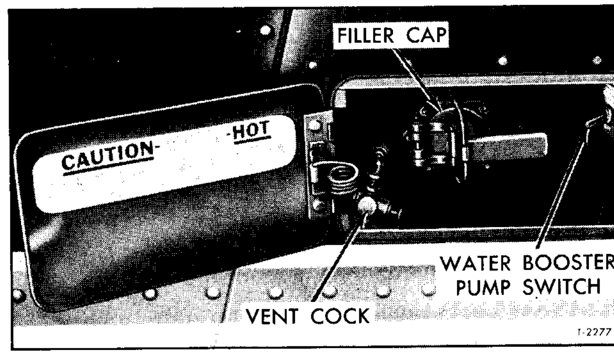


Figure 1—Cooling System Filler Cap, Vent Cock, and Water Booster Pump Switch

CIRCULATION

Coolant circulation during warm up differs from circulation after engine has reached normal operating temperature as explained in following paragraphs.

ENGINE WARM-UP

The two temperature control thermostats are located in a housing at front of engine. Water pump

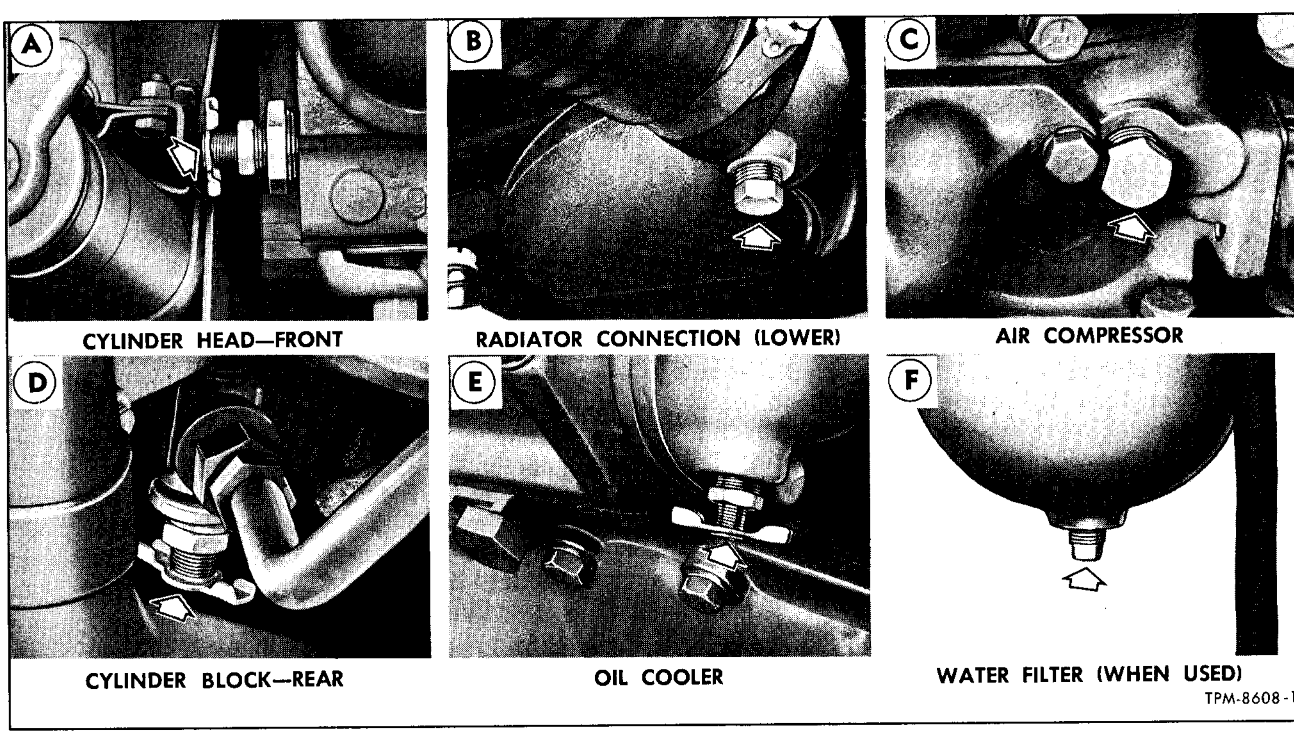
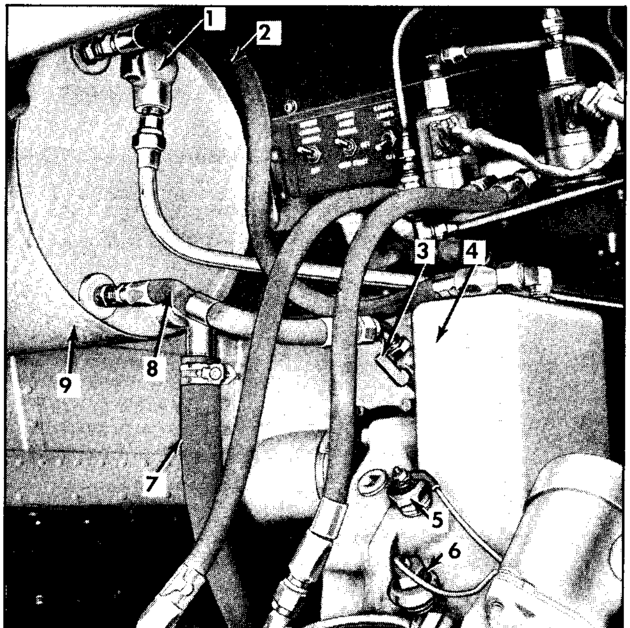


Figure 2—Location of Cooling System Drain Points



1 Pressure Relief Valve
2 Surge Tank to Engine Hose Assembly
3 Shut-off Cock
4 Thermostat Housing
5 Overheat Sending Unit
6 Temperature Sending Unit
7 Surge Tank to Outlet Hose Assembly
8 Surge Tank to Thermostat Housing (Vent Line)
9 Surge Tank
10 Overflow Tube

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Figure 3—Surge Tank, Thermostat Housing, and Lines

pumps coolant into cylinder block, by way of engine oil cooler. After circulating through block and cylinder heads coolant enters thermostat housing. When engine is cold (below 170°) the thermostats are closed and prevent coolant from flowing to radiator; so the coolant returns to water pump through by-pass openings in housing, and through surge tank. During warm-up, coolant also circulates through air compressor cylinder head.

AFTER WARM-UP

When coolant reaches temperature at which thermostats open, normal flow is not restricted and coolant now flows into top of radiator, down through radiator (where it is cooled) to water pump, through oil cooler, engine block and back to thermostat housing, thus completing cycle. The flow of coolant continues through by-pass openings in thermostat housing, air compressor and surge tank when engine is operating at normal temperature.

DRAINING COOLING SYSTEM

Drain cocks are provided at engine, radiator, and in heating system. A shut-off valve in heater line can be closed to permit draining engine without draining heater lines. Press and hold relief valve (vent cock) at surge tank to relieve pressure, then block filler cap open to vent cooling system while draining. Open drain cocks and remove plugs at points indicated below:

ENGINE COOLING SYSTEM DRAIN POINTS

1. Remove drain plug from radiator outlet connection at bottom of radiator (B, fig. 2).
2. At air compressor, remove plug at side of cylinder block (C, fig. 2).
3. At bulkhead side of engine, open drain cock at oil cooler inlet (E, fig. 2).
4. At rear side of engine, open drain cock at front of cylinder block (A, fig. 2), and drain cock in air compressor water line fitting at cylinder block (D, fig. 2).
5. When used as special equipment, remove plug from bottom of filter housing (F, fig. 2).
6. Refer to HEATING AND AIR CONDITIONING (SEC. 26) for instructions covering draining of heater lines.

FILLING COOLING SYSTEM

Only pure, soft water and ethylene glycol type antifreeze should be used in cooling system. Additional information concerning use of antifreeze is given later in this section.

FILLING EMPTY SYSTEM

1. Close all drain cocks and install drain plugs, referring to draining procedure for location of drain points. If heater line gate valve is closed, it should be opened.
2. Open shut-off cock in vent line at top of thermostat housing at front of engine (fig. 3).
3. Open filler cap (fig. 1) and slowly fill system to level of filler cap opening.
4. Start engine and run at fast idle until normal operating temperature is reached. Leave engine running at normal idle.
5. Hold lever of "WATER BOOSTER PUMP" switch (fig. 1) up for a minute or more; this will speed up circulation through entire system.
6. Check level of coolant, add if necessary. Refer to HEATING AND AIR CONDITIONING (SEC. 26) for instructions on bleeding heating units when filling a completely empty system.
7. After all lines have been bled, close vent line shut-off cock at fitting in top of thermostat housing (fig. 3). Closing vent line shut-off cock during operation is necessary to prevent water flow through surge tank and radiator with closed thermostats to insure benefits of the Posi-Temp cooling system.

REPLENISHING COOLING SYSTEM

1. Press relief valve button (vent cock) on surge tank, and hold in depressed position until all pressure is relieved from system.

CAUTION: If engine is overheated, wait until

boiling stops and engine has cooled before adding cold water. Then with engine running, add water slowly as directed in step 2 following.

2. Open filler cap (fig. 1). Slowly fill system to level of filler cap opening.

3. If water in cooling system was very low, bleed heating system units to make sure all air is expelled. Refer to HEATING AND AIR CONDITIONING (SEC. 26).

COOLING SYSTEM INSPECTION AND MAINTENANCE

PERIODIC INSPECTION

At regular intervals, cooling system units should be inspected to determine if service is required. Regular systematic checks will indicate condition of various units and indicate necessity of servicing or replacement of units which can be made before failures occur.

1. At surge tank, check coolant level by pressing vent cock button. If liquid flows out, system contains adequate solution. If coolant is low add as necessary. NOTE: Refer to previous instructions for filling cooling system.

2. Check hose connections and tighten clamps as necessary. Cracked, swollen, or deteriorated hoses must be replaced.

3. Check radiator core and heater cores for leaks and for accumulation of dirt which obstructs air passage. Clean cores with air hose using low pressure. Repair all cooling system leaks when discovered. Refer to applicable DIESEL ENGINE MANUAL for procedure to remove and overhaul water pump.

4. Inspect the radiator mountings and tighten mounting bolts when necessary.

5. If radiator is equipped with shutters, check operation of shutter air cylinder, and service the air filter.

6. Inspect for clearance between fan blades and radiator. Correct as instructed later in this section under heading "Radiator and Surge Tank."

7. Inspect and service water filter (if used) as directed under "Water Filter" later in this section.

WATER FILTER

Water filter (fig. 4) as installed on some vehicles is used to filter and condition water in cooling system. On a new engine, the filter element should be initially changed after 2,500 to 3,000 miles. After initial change, the filter should be serviced periodically 7,500 to 10,000 miles or 300 to 500 hours depending upon engine workload, conditions, etc.

Except when antifreeze is used, color of water in system should be a golden yellow. No rust preventive or inhibitor should be used in system when water filter is used.

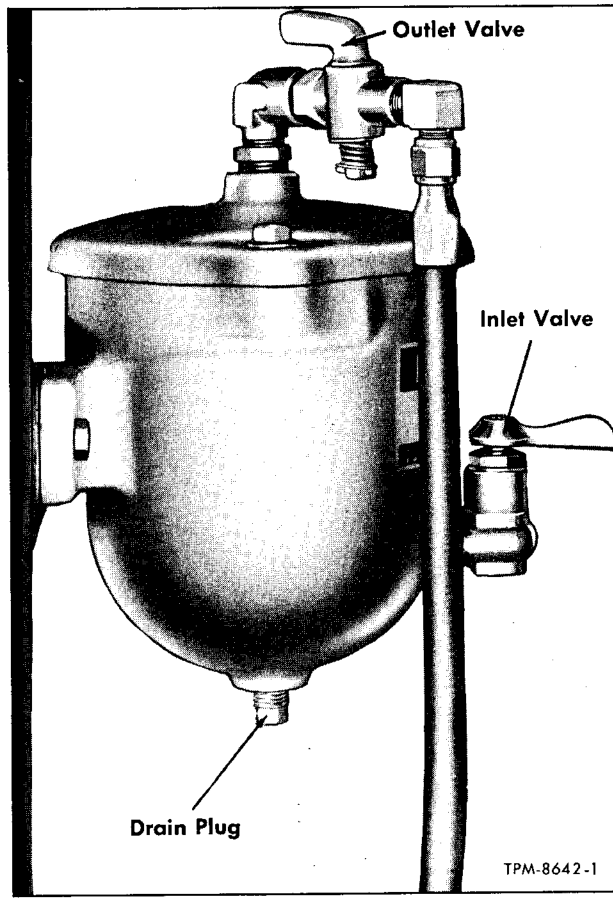


Figure 4—Water Filter Installed

IMPORTANT: Some permanent-type antifreeze solutions may contain inhibitor which will produce a green residue or precipitation. If this is noted more frequent element change periods will be necessary and if this fails to correct condition, the filter element should be removed, or the filter disconnected.

ELEMENT REPLACEMENT

NOTE: Key numbers in text refer to figure 5.

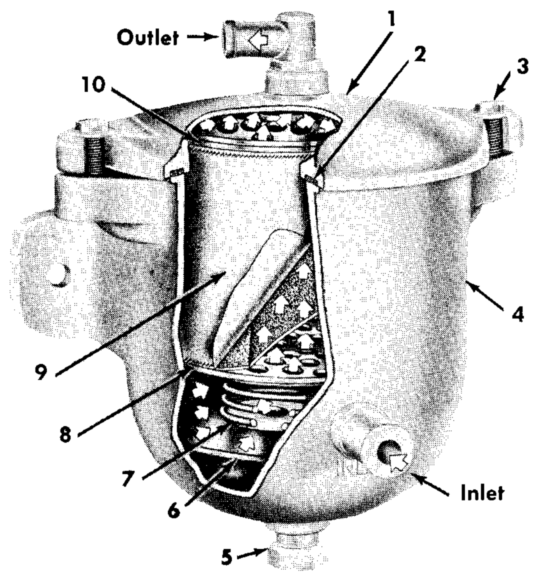
1. For convenience in changing element, close off filter supply and return hose by closing the two valves (fig. 4).

2. Remove two bolts (3) which attach cover (1) to filter. Remove cover and cover gasket (2).

3. Remove drain plug (5) from bottom of filter.

4. Remove upper plate (10), element (9), lower plate (8), spring (7), and sump plate (6) from filter body (4). Flush out filter body.

5. Discard filter element, then clean all parts. Examine element lower plate for excessive corrosion. Deep pits in the plate do not warrant replacement. Clean plate by wire brushing. This



1 Cover	6 Sump Plate
2 Gasket	7 Spring
3 Bolt	8 Lower Plate
4 Body	9 Element
5 Drain Plug	10 Upper Plate

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Figure 5—Water Filter Assembly

plate generates current for the electrochemical action of filter element. If excessively corroded, replace.

NOTE: During winter, when using ethylene glycol antifreeze solutions, install element identified by letters "PAF." When operating in mild climates where no antifreeze is required, use the standard chromate type filter element.

6. Referring to illustration, position sump plate (6), spring (7), lower plate (8), new element (9), and upper plate (10) in filter body (4). Install cover (1) using new gasket (2). Tighten cover attaching bolts evenly and firmly.
7. Open inlet and outlet valves (fig. 4). Start and operate engine until water in cooling system is warm. Check for air lock in filter. If cover of filter becomes warm no air-lock condition exists in system. If cover remains cool, vent system same as for a hot water heater system.
8. Refill system to proper level.
9. IMPORTANT: Make sure that filter body is grounded, otherwise electrochemical action of filter element will be affected.

ENGINE THERMOSTATS

Engine thermostats are located in thermostat housing at front of engine (fig. 3).

When engine is cold, the thermostats are closed and prevent water from circulating through radiator; instead, the coolant passes through by-pass to water pump where it is pumped through oil cooler and returned to cylinder block.

Proceed as follows to replace thermostats:

1. Close shut-off valve in heater line and open drain cock in end of cylinder head to drain water level below thermostat housing. Plug at bottom of radiator may be removed to drain out water more rapidly.
2. Loosen hose clamps on by-pass hose, also hose clamps on radiator inlet hose.
3. Remove bolts which attach thermostat housing, then remove housing and two thermostats.
4. Place thermostats in position in housing with element toward engine. Install thermostat housing using new gasket. Fit the thermostat housing into by-pass and radiator pipe hoses before installing housing bolts.
5. After installing housing bolts, position hose and tighten clamps. Fill cooling system, start engine, and inspect hose connections for leaks.

TEMPERATURE GAUGE

An electrically operated temperature gauge on instrument panel registers coolant temperature. Sending unit is installed in engine thermostat housing. Circuit does not operate when "ENGINE RUN" switch is in "STOP" position.

Refer to "Alarm and Signal Wiring Diagram" for electrical wiring circuits when tracing wiring between sending unit and gauge. The sending unit is installed in tapped boss adjacent to engine overheat switch (fig. 3). DO NOT USE THREAD COMPOUND ON SENDING UNIT THREADS when installing.

WATER TEMPERATURE (OVERHEAT) SWITCH

A tell-tale light in instrument panel and alarm buzzer are used to warn driver of overheated engine. Overheat switch is installed in thermostat housing and is connected to wiring harness. Switch is shown in figure 3. Switch is a sealed unit and is not adjustable.

OPERATION

Engine overheat switch has internal contact points which are normally open at temperatures below 210°F. In case engine temperature rises to 210°F. to 214°F., the contact points will close and complete the electrical circuit which causes tell-tale to light and buzzer to operate.

OVERHEAT SWITCH REPLACEMENT

1. Disconnect wire from terminal on switch,

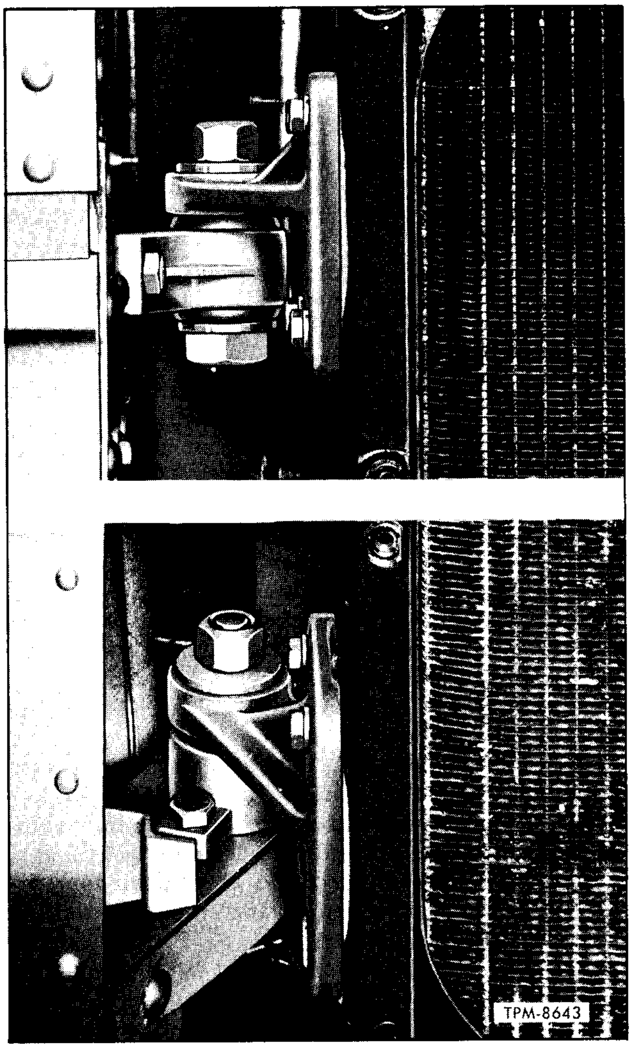


Figure 6—Radiator Brackets

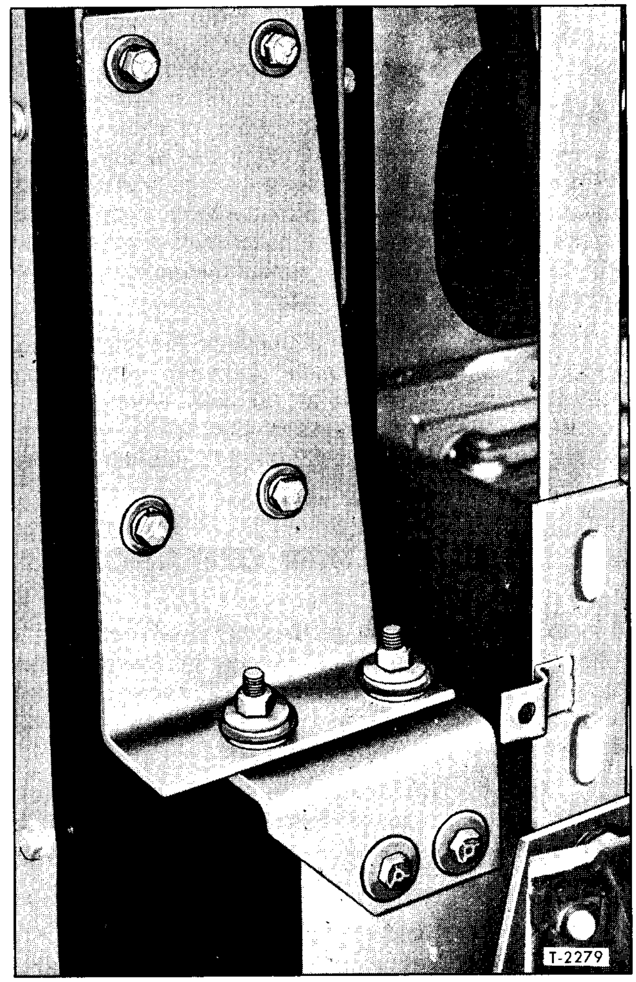


Figure 7—Radiator Support

then use wrench to screw switch body out of thermostat housing.

2. Screw switch into housing and tighten firmly. DO NOT USE COMPOUND ON SWITCH BODY THREADS. Threads are dry-seal type. Use of compound may prevent proper transfer of heat and hinder flow of electric current.

3. Connect wire to terminal.

RADIATOR COOLING FAN

A mechanically driven six-bladed fan for cooling radiator is installed at front end of engine. The fan blade assembly is secured with six bolts and self-locking nuts to flange on fan hub assembly. The fan hub assembly is secured to the mechanical fan and accessory drive assembly. For maintenance of the mechanical fan and accessory drive assembly, refer to HEATING AND AIR CONDITIONING (SEC. 26).

RADIATOR AND SURGE TANK

Radiator is located at left rear side of coach and is covered by a grille door. Radiator is mounted to body by two rubber insulated brackets(fig. 6). Radiator is held in position by two rubber mounted bolts (fig. 7). Surge tank, installed above radiator, is equipped with pressure valve assembly. Pressure valve incorporates two valves; one which relieves excessive pressure and another which admits atmosphere as coolant contracts after engine is stopped. An overflow tube is connected to the pressure valve.

RADIATOR INSPECTION

At regular intervals, check core attaching bolts for tightness. Inspect radiator brackets (fig. 6) and radiator support (fig. 7) for excessive wear or deterioration of rubber insulators. Replace if necessary.

COOLING SYSTEM

At regular intervals, or when operating conditions warrant, examine radiator core for leaks and bent fins. A damaged or clogged radiator should be serviced by a radiator specialist or replaced with a new one. Efficient repair of radiators requires the use of special tools and equipment as well as provisions for making proper tests. If radiator core requires painting, spray with special radiator paint; do not use paint mixed with oil, as oil mixed paint will form an insulation and prevent efficient dissipation of heat.

Check for clearance between fan blades and radiator shroud. Distance between blades and shroud should be equal all around. Whenever adjustment is necessary, shroud attaching bolts can be loosened and shroud adjusted to provide proper clearance.

COLD WEATHER OPERATION

In cold regions, antifreeze must be used in cooling system to prevent damage by freezing. Before installing antifreeze solution, cooling system should be inspected and serviced as previously described under "Periodic Inspection."

Tighten cylinder head bolts and, if necessary, replace gasket, to prevent leakage of antifreeze into engine and blowing of exhaust gases into cooling system.

THAWING COOLING SYSTEM

If coolant freezes solid, place coach in a warm building until ice is completely thawed.

CAUTION: UNDER NO CIRCUMSTANCES SHOULD ENGINE BE RUN WHEN COOLING SYSTEM IS FROZEN SOLID.

ANTIFREEZE SOLUTIONS

Only ethylene-glycol type anti-freeze solution is recommended for use in these vehicles. Ethylene-glycol solutions have the advantage of a higher boiling point and may be used at higher temperature without loss, resulting in more efficient performance of cooling system. Ethylene-glycol has the further advantage that, in a tight system, only water is required to replace evaporation losses. However, losses through leakage or foaming must be replaced by additional new solution. Under ordinary conditions, ethylene-glycol solutions are not injurious to body finish.

Anti-freeze solution should be drained and discarded at the end of each season.

Testing Anti-Freeze Solution

Always test solution before adding water or anti-freeze. Engine should be warmed up to operating temperature. Fill and empty tester several times to warm tester before using. Keep tester clean inside and out.

Some testers will indicate correct freezing point only when test is made at a specific temperature. Other testers are provided with thermometers and tables and indicate freezing points corresponding to readings made at various temperatures. Disregarding temperatures of solution may cause an error as large as 30°F. Read and be guided by instructions furnished by tester manufacturer.

SPECIFICATIONS

COOLING SYSTEM CAPACITIES

Quarts of Coolant Required (Approx.)*	92

*Includes Heating System.

ANTI-FREEZE CHART
(Based On 92 Qt. System)

Lowest Expected Temp. (°F.)	Qts. of Ethylene Glycol Required
+10	23
0	30½
−10	35
−20	39½
−30	43½

THERMOSTAT—WATER CIRCULATION

Number Used	2
Start to Open	170°
Fully Open	185°

OVERHEAT SWITCH (ALARMSTAT)

Make	AC
Vendor No.	1513806
Points Set to Close at	212°F ±2°

SURGE TANK PRESSURE VALVE

Valve Opens at (Pressure in Lbs. per Sq. In.)	3½ to 4½

FAN

Number of Fan Blades	6
Diameter	30″
Direction of Rotation	Counterclockwise

TEMPERATURE GAUGE

Make	AC
Number	6402012
Operating Range	100°-260°
Voltage	14.5

Electrical System

WARNING: This coach is equipped with a NEGATIVE GROUND electrical system.

This group, covering complete maintenance and repair information on Electrical Systems, is divided into six sections as shown in index below:

NOTE: Specifications are listed at end of each specific section.

INDEX OF ELECTRICAL UNITS

Certain electrical units, when closely associated with some other system or unit, are covered in other sections of this manual. The index following lists all major electrical units, together with the manual section in which they are covered and page number on which the section begins:

Wiring and Miscellaneous Electrical

ELECTRICAL CIRCUIT DIAGRAMS

The electrical system is divided into several separate systems, each system being classified according to its function or purpose. A separate wiring diagram is provided for each major system. In some cases, a circuit on one diagram ties-in with circuits shown on other diagrams, and cross-references are made to other diagrams. Wiring diagrams are inserted in back of this manual. These diagrams include all standard diagrams, and diagrams covering the most commonly used special equipment. Following is a list of wiring diagrams included in this manual.

MD97593 - Engine Control and Generator Wiring Diagram
MD97596 - Alarm and Signal Wiring Diagram
MD98684 - Coach Lighting Wiring Diagram
MD97599 - Directional Lamp Wiring Diagram
MD97597 - Transmission Wiring Diagram
MD97103 - Speedometer Wiring Diagram
MD98247 - Heating and Air Conditioning Wiring Diagram
MD97595 - Lavatory Wiring Diagram
MD99314 - Windshield Wiper Wiring Diagram

WIRE SIZES AND COLORS

Each wire in the electrical system is of a specific size as designated on the Wiring Diagrams. When replacing wires, the correct size as indicated must be used. Never replace a wire with one of a smaller size.

The insulation on each wire is distinctly colored and patterned to assist in tracing and testing circuits, and to assist in making connections.

Abbreviations and symbols are used in wire insulation color and pattern designations on Wiring Diagrams and in the tabulations which follow. Abbreviations and symbols are as follows:

*Blk.	Black	Nat.	Natural
Brn.	Brown	Or.	Orange
Ch.	Check	Tr.	Tracer
Cr.	Cross	Yell.	Yellow
Grn.	Green	//	Parallel

*All wires leading from electrical compartment junction box into engine compartment are covered with black heat-resistant insulation. To assist in making proper connections, a tag near end of each wire bears the number or abbreviation of the terminal to which it connects.

TESTING CIRCUITS

A careful study of the wiring diagrams should be made to determine the source and flow of current through each electrical circuit. When a circuit is thoroughly understood, a point to point check can be made with the aid of the applicable wiring diagram, to determine location of trouble. Any circuit can be tested for continuity or short circuits with a 2-candlepower test light or voltmeter.

All electrical connections must be kept clean and tight. Loose or corroded connections will cause discharged battery, difficult starting, dim lights, and improper functioning of other electrical circuits. Inspect all wiring connections at regular intervals. Make sure knurled nuts on all amphenol plugs are securely tightened. Refer to other sections previously listed under "Index of Electrical Units" for information on major electrical units and systems.

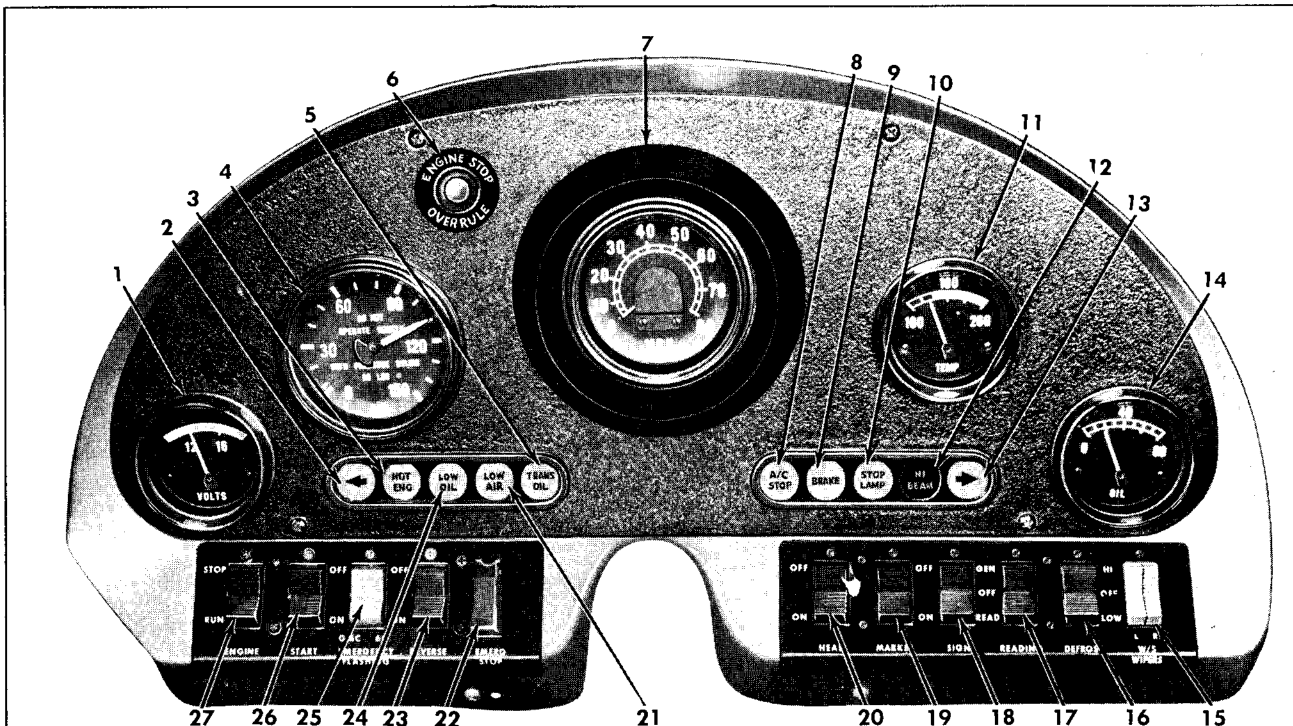
GAUGE, SWITCH, AND TELL-TALE PANEL

Gauge, switch, and tell-tale panel (fig. 1), mounted directly in front of driver, contains the necessary gauges, switches and tell-tale lights to determine condition of systems within coach. Instrument cluster contains five gauges, ten tell-tale lights, and eleven switches. The gauges installed on instrument cluster are the Air Pressure Gauge, Engine Temperature Gauge, Oil Pressure Gauge, Generator Charge Indicator, and Speedometer. The tell-tale lights are the Transmission Oil, Low Air, Low Oil, Hot Engine, Hand Brake, Air Conditioning Stop, Stop Lamp, Directional Signals and Hi-Beam. The switches are the engine run, starter, emergency flashing, reverse, emergency stop, defrost, head lamp, sign, marker, reading, and windshield wipers. The engine stop overrule switch is used as special equipment.

Snap-in type instrument light sockets are a part of the wiring harness assembly. Light bulbs are accessible by pulling socket out of holder on back of panel.

DRIVER'S CONTROL PANEL

Control panel shown in figure 2, located at left of driver, contains switches, in addition to those on the instrument panel explained above. All switches are clearly marked for positive identification. The switches are the chime, driver's lamp, fan, fast idle, air condition, and temperature range rheostat. Additional plates on panel are provided for special equipment applications.



1 Voltmeter Gauge
2 Directional Signal - Tell-tale (Left-Hand)
3 Hot Engine - Tell-tale
4 Air Pressure Gauge
5 Transmission Oil - Tell-tale
6 Engine Stop Overrule - Switch (Special Equipment)
7 Speedometer - Gauge
8 Air Conditioning Stop - Tell-tale
9 Parking Brake - Tell-tale
10 Stop Lamp - Tell-tale
11 Water Temperature Gauge
12 Hi Beam - Tell-tale
13 Directional Signal - Tell-tale (Right-Hand)
14 Oil Pressure - Gauge
15 Windshield Wiper Motor - Switches
16 Defroster Blower - Switch
17 General Lighting and Reading Lamp - Switch
18 Destination Sign - Switch
19 Marker Lamp - Switch
20 Head Light - Switch
21 Low Air - Tell-tale
22 Engine Emergency Stop - Switch
23 Transmission Reverse - Switch
24 Low Engine Oil - Tell-tale
25 Emergency Flasher Light - Switch
26 Engine Starter - Switch
27 Engine Run - Switch

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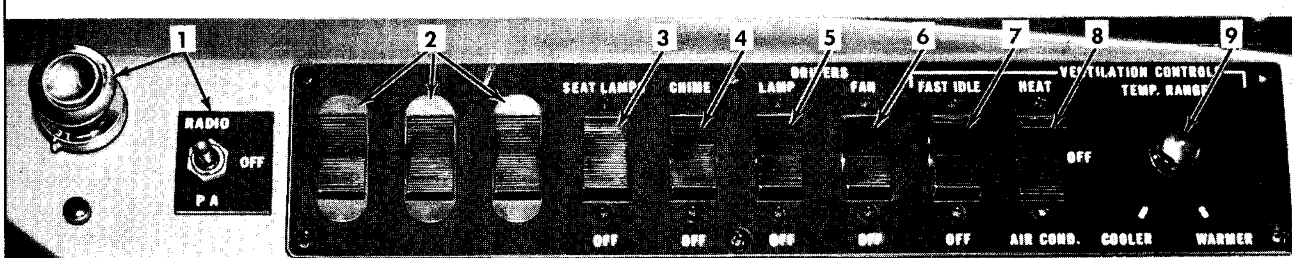
Figure 1—Gauge, Switch, and Tell-Tale Panel



1 Radio Controls (Special Equipment)
2 Switch Openings for Special Equipment
3 Seat Lamp Switch
4 Passenger Signal Chime Switch
5 Driver's Lamp Switch
6 Driver's Fan Switch
7 Engine Fast Idle Switch
8 Heating and Air Conditioning Switch
9 Temperature Range Rheostat

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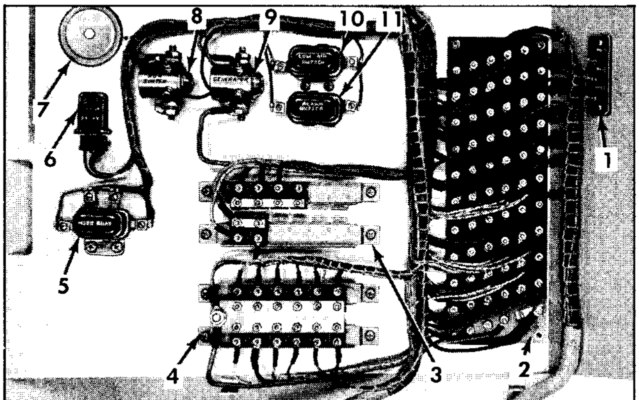
Figure 2—Driver's Control Panel

DRIVER'S CONTROL PANEL JUNCTIONS



1 Junction Block (Special Equipment)
2 Junction Block
3 Circuit Breaker Bar
4 Circuit Breaker Bar
5 Horn Relay
6 Stop Lamp Relay
7 Fire Alarm (Special Equipment)
8 Engine Run Magnetic Switch
9 Generator Magnetic Switch
10 Low Air Alarm Buzzer
11 Low Engine Oil or Hot Engine Alarm Buzzer

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Figure 3—Driver's Control Panel Junction Box

Junction panel (fig. 3), located below the control panel at left of driver, is accessible after removing the junction, circuit breaker, and electrical apparatus panel cover. Junction panel contains 64 terminal posts, numbered consecutively from 1 through 64. Numbers on panel correspond to numbers on Wiring Diagrams and in tabulations which follow. The tabulation lists each terminal number, the circuit it carries, and the size, color, and pattern of the wire which connects to each terminal. Some of the unused terminals, marked "Open" or "Spare" in the tabulation, are available for use with additional special electrical equipment. Driver's control panel junction numbers appear in the symbol ⏥ on Wiring Diagrams.

Terminal No.	Circuit	Wire Size	Color Code
1	From Stop Lamp Switch to Stop Lamp Relay	16	Red - Nat. Tr.
2	From Emergency Stop Switch to Emergency Comp't. Jct. 2	14	Grn. - Red Ch.
3	From Transmission Reverse Switch to Engine Comp't. Junction 3	14	Blk. - 2 Red // Tr.
4	From Engine Alarm Buzzer to Engine Comp't. Jct. 4 . .	16	Grn. - Blk. Tr.
5	From Oil Pressure Gauge to Engine Comp't. Jct. 5 . . .	16	Grn. - Nat. Cr. Tr.
6	Instrument Panel and Marker Lamp Circuits:		
	From Marker Lamp Switch	14	Brn. - Blk. Tr.
	To Front Marker Lamps	14	Brn. - Blk. Tr.
	To Engine Compartment Junction 6	14	Brn. - Blk. Tr.
	To Battery Compartment Junction 5L	14	Brn. - Blk. Tr.
7	From Speedometer Head Insulated Stud to Engine Comp't. Junction 7	16	Blk. - Nat. Tr.
8	Low Air System Circuits:		
	From Low Air Tell-tale Lamp	16	Or. - 2 Grn. // Tr.
	From Low Air Buzzer	16	Or. - 2 Grn. // Tr.
	To Low Air Switch	16	Or. - 2 Grn. // Tr.
9	*Spare (Fire Detector) to Engine Comp't. Jct. 9	16	Grn. - 2 Red // Tr.
10	Head Lamp and Tail Lamp Circuits:		
	From Head Lamp Switch	14	Brn.
	To Dimmer Switch	14	Brn.
	To Engine Compartment Junction 10	16	Brn.
11	From Stop Lamp Relay to Engine Comp't. Jct. 11	16	Red - 2 Nat. // Tr.
12	From Stop Lamp Relay to Stop Lamp Tell-tale	16	Red - Blk. Tr.
13	From Transmission Low Oil Tell-tale to Engine Comp't. Junction 13	16	Blk. - Red Tr.
14	From Hot Engine Tell-tale to Engine Comp't. Jct. 14 . . .	16	Grn. - 2 Blk. // Tr.
15	From Engine Temp. Gauge to Engine Comp't. Jct. 15 . . .	16	Grn. - Blk. Cr. Tr.
16	From Engine Run Switch to Engine Run Magnetic Switch . .	14	Grn.
17	From Speedometer Head Ground Stud To Engine Comp't. Junction 17	16	Blk. - 2 Nat. // Tr.
18	From Watch Step Relay Terminal No. 1 to Watch Step Sign and Nite Lamp	16	Nat.

*Special Equipment.

DRIVER'S CONTROL PANEL JUNCTIONS (CONT'D)

Terminal No.	Circuit	Wire Size	Color Code
19	From Starter Switch to Engine Compartment Junction 19 .	14	Grn. - 2 Brn. // Tr.
20	*Spare (To Engine Comp't. Jct. 20)	16	Or. - 2 Blk. // Tr.
21	Right-Hand Directional Signal Lamp Circuits:		
	From Right-Hand Pilot Relay	16	Red - 2 Grn. // Tr.
	To Right-Hand Front Directional Lamp Harness Connector	16	Red - 2 Grn. // Tr.
	To Right-Hand Side Directional Lamp	16	Red - 2 Grn. // Tr.
	To Engine Compartment Junction 21	16	Red - 2 Grn. // Tr.
22	Engine Control Circuits:		
	From Circuit Breaker No. 2	14	Grn.
	To Air Brake Switch	16	Grn.
	To Engine Compartment Junction 22	14	Grn.
	To Entrance Door Switch and Watch Step Relay Terminal No. 2	16	Grn.
23	*From Overrule Switch to Engine Comp't. Jct. 23	14	Grn. - Red Tr.
24	From Low Oil Tell-tale to Engine Comp't. Jct. 24	16	Grn. - 2 Nat. // Tr.
25	From Fast Idle Switch to Engine Comp't. Jct. 25	16	Grn. - Nat. Tr.
26	Open		
27	*Speedometer Circuit:		
	*To Engine Compartment Junction 27	16	Blk. - Grn. Tr.
28	Air Brake Circuit:		
	From Air Brake Switch	16	Grn. - Nat. Tr.
	To Fast Idle Switch	16	Grn. - Nat. Tr.
	To Air Brake Tell-tale	16	Grn. - Nat. Tr.
29	Starter Switch Circuit:		
	From Starter Switch	14	Grn. - Brn. Cr. Tr.
	To Engine Alarm Buzzer	14	Grn. - Brn. Cr. Tr.
	To Engine Compartment Junction 29	14	Grn. - Br. Cr. Tr.
30	*Spare (To Engine Compartment)	16	Blk. - Red Cr. Tr.
31	Left-Hand Directional Lamp Circuit:		
	From Left-Hand Pilot Relay	16	Red - Grn. Cr. Tr.
	To Left-Hand Front Directional Lamp Line Connector .	16	Red - Grn. Cr. Tr.
	To Left-Hand Side Directional Lamp	16	Red - Grn. Cr. Tr.
32	From Dimmer Switch to High Beam Tell-tale	16	Brn. - Nat. Cr. Tr.
33	From Destination Sign Switch to Destination Sign Line Connector	16	Brn. - Blk. & Nat. Cr. Tr.
34	From Interior Light Switch to Reading Lamp Magnetic Sw..	16	Nat. - 2 Blk. // Tr.
35	From Interior Light Switch to General Lamp Magnetic Sw. .	16	Nat. - Blk. Tr.
36	*Spare (To Engine Comp't. Jct. 36)	16	Blk. - 2 Red // Tr.
37	*Speedometer Circuit:		
	To Engine Compartment Jct. 37	16	Blk. - 2 Grn. // Tr.
38	*From Circuit Breaker No. 1 to Battery Comp't. Jct. 3L . .	14	Blu. - Nat. Cr. Tr.
39	*From Battery Compartment Junction 2L to Emerg. Buzzer .	16	Blu. - Nat. Tr.
40	Open		
41	Open		
42	From Generator Magnetic Sw. to Battery Compartment Circuit Breaker No. 6	14	Gray
43	From Temp. Control to Ventilation Comp't. Jct. 5	16	Yell. - 2 Blu. // Tr.
44	From Heating & Air Conditioning Sw. to Ventilation Comp't. Jct. 4 and Blower Motor Magnetic Switch	14	Yell.
45	From Heating & Air Conditioning Sw. to Battery Comp't.. Jct. 3R and Blower Motor Magnetic Switch	14	Yell. - 2 Red // Tr.
46	From Air Condition Tell-tale to Battery Comp't. Jct. 6L .	16	Yell. - Blk. Cr. Tr.
47	From Defroster Switch to Defroster Fan Harness Connector	14	Yell. - 2 Blk. // Tr.
48	From Defroster Switch to Defroster Fan Harness Connector	14	Yell. - Blk. Cr. Tr.
49	From Horn Relay to Horn	10	Brn. - Blk. & Red Cr. Tr.
50	From Horn Relay to Directional Switch Connector	16	Brn. - Red Ch.
51	*From Seat Lamp Switch to Battery Jct. 4R	16	Nat. - Blk. Cr. Tr.
52	From Driver's Lamp Switch to Driver's Lamp Line Connector	16	Nat. - Grn. Tr.
53	From Driver's Fan Sw. to Driver's Fan Line Connector . .	16	Yell. - Blu. Tr.
54	*Wheel Sander Circuit:		
	From Wheel Sander Switch	10	Nat.
	To Engine Compartment Junction 54	10	Red - Grn. Tr.

*Special Equipment.

Continued on next page.

WIRING AND MISC. ELEC.

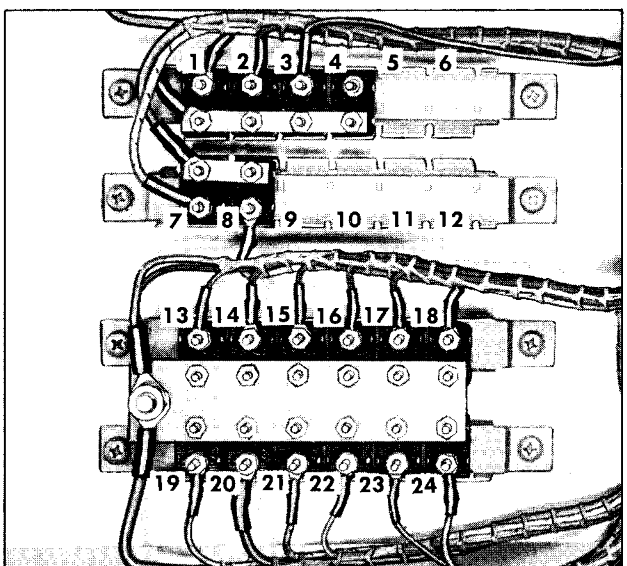
DRIVER'S CONTROL PANEL JUNCTIONS (CONT'D)

Terminal No.	Circuit	Wire Size	Color Code
55	*To Ventilation Comp't. Junction 2 (Fuel Gauge Circuit)	16	Or. - Grn. Tr.
56	*Spare (To Ventilation Compartment)	16	Blk. - Nat. Cr. Tr.
57	From Passenger Chime to Chime Switch	16	Grn. - Red Ch.
58	From Chime Switch to Left- and Right-Hand Passenger Signal Switch	16	Grn. - Red Ch.
59	Open		
60	From Circuit Breaker No. 2 to Stop Lamp Switch	16	Red
61	Open		
62	From Step Lamp Switch to Step Lamp Line Connector and Watch Step Relay Terminal No. 4	16	Or.
63	Open		
64	From Instrument Panel Ground to Ground	12	Blk.

*Special Equipment.

DRIVER'S CONTROL PANEL CIRCUIT BREAKERS

Circuit breaker panel (Items 3 and 4, fig. 3), located on the apparatus panel at left of driver's seat, is accessible after removing the panel cover.



1 10-Amp	7 10-Amp	13 8-Amp	19 10-Amp
2 8-Amp	8 10-Amp	14 15-Amp	20 10-Amp
3 8-Amp	9 Open	15 10-Amp	21 8-Amp
4 20-Amp	10 Open	16 10-Amp	22 8-Amp
5 Open	11 Open	17 15-Amp	23 8-Amp
6 Open	12 Open	18 10-Amp	24 8-Amp

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Figure 4—Driver's Control Panel Circuit Breakers

Panel has space for 24 circuit breakers, however, only 17 are used on coaches with standard electrical equipment. Additional circuit breakers may be used with special equipment.

Circuit breakers are automatic reset type, protecting various circuits as indicated in the tabulation which follows. Any condition which causes an overload on a circuit, such as a short, will cause circuit breaker bimetallic element to open circuit; when element cools, circuit breaker will again close circuit. This off and on cycle will repeat until switch controlling defective circuit is turned off, or until cause of overload has been located and corrected. In the event a circuit breaker becomes defective (burns out or sticks closed), the defective circuit breaker must be replaced.

Circuit breaker numbers shown on Wiring Diagrams and in the tabulation which follows do not appear on the circuit breakers or on the panel; to identify circuit breakers, it is necessary to refer to diagram shown in figure 4. Amperage rating of each circuit breaker is also shown in figure 4. Circuit breakers must be installed so the feed or battery wire (or bus bar) connects to the "BAT" or short terminal, and the wire carrying the circuit to the electrical units connects to the "AUX." or long terminal.

The following tabulation lists each circuit breaker number (as identified in figure 4), the circuit it protects, and the size, color, and pattern of the wire (or wires) which connect to the circuit breaker terminals.

Circuit Breaker Tabulation on Next Page.

DRIVER'S CONTROL PANEL CIRCUIT BREAKERS (CONT'D)

Breaker No.	Circuit	Wire Size	Color Code	Fed From
1	*To Driver's Control Panel Jct. 38 . .	14	Blu. - Nat. Cr. Tr.	Engine Run Magnetic Switch
2	To Driver's Control Panel Jct. 22 . .	14	Grn.	Engine Run Magnetic Switch
3	To Engine Starter Switch	14	Grn. - Red Cr. Tr.	Engine Run Magnetic Switch
4	To Windshield Wiper Relay	14	Grn. - Red Tr.	Engine Run Magnetic Switch
5	Open			
6	Open			
7	To Heating and Air Conditioning Sw. .	12	Yell. - Blk. Tr.	Generator Magnetic Switch
8	To Defroster Switch	14	Yell.	Generator Magnetic Switch
9	Open			
10	Open			
11	Open			
12	Open			
13	To Interior Lighting Switch	16	Nat. - Red Tr.	Battery
14	To Head Lamp Switch	14	Brn.	Battery
15	To Marker Lamp Switch	14	Brn. - Blk. Tr.	Battery
16	To Destination Sign Switch.	16	Brn.-Blk. & Nat.Cr. Tr.	Battery
17	To Flasher Unit	16	Red	Battery
18	To Baggage Comp't. Lamp Sw. Harness	14	Or. - Red Tr.	Battery
19	To Driver's Fan Switch	16	Yell. - Blue. Tr.	Battery
20	To Horn Relay	10	Brn.	Battery
21	To Driver's Lamp Switch	16	Nat. - Blk. Cr. Tr.	Battery
22	To Driver's Control Panel Junction 60	16	Red	Battery
23	To Passenger Chime	16	Grn. - Red Ch.	Battery
24	To Engine Run Switch	14	Red	Battery

*Special Equipment.

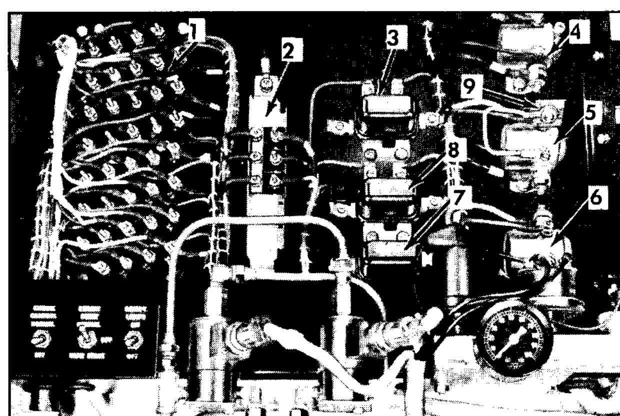
ENGINE COMPARTMENT APPARATUS BOX

Engine compartment apparatus box (fig. 5) is located on the engine compartment bulkhead at upper left side. Access to components is attained by removing three screws securing cover and lifting cover from box.

Components installed in engine compartment apparatus box are identified in figure 5.

Terminal posts on junction panel are numbered from 1 through 38. Numbers on panel correspond to numbers on Wiring Diagrams and in the tabulation which follows. The tabulation lists each terminal number, the circuit it carries, and the size, color, and pattern of the wires which connect to the terminal. Some of the unused terminals, marked "Open" or "Spare" in the tabulation, may be used for special electrical equipment. Terminal post numbers on junction panel appear on Wiring Diagrams in the symbol □.

NOTE: Wires leading from the junction panels into the engine compartment are covered with a special black heat-resistant insulation.



1 Junction Panel
2 Circuit Breaker Carrier
3 Automatic Engine Stop Relay (Special Equipment)
4 Reverse Magnetic Switch
5 Starter Magnetic Switch
6 Emergency Stop Magnetic Switch
7 Hot Engine Relay
8 Engine Low Oil Relay
9 Rectifier

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Figure 5—Engine Compartment Apparatus Box

ENGINE COMPARTMENT APPARATUS BOX JUNCTIONS

Terminal No.	Circuit	Wire Size	Color Code
1	Engine Control Circuits:		
	From Engine Rear Start Switch	14	Grn. - Blk. Cr. Tr.
	To Regulator Sensing Magnetic Switch	14	Grn. - Blk. Cr. Tr.
	To Hot Engine Relay Terminal #4	16	Grn. - Blk. Cr. Tr.
2	From Driver's Control Panel Jct. 2 to Emergency Stop Magnetic Switch	14	Grn. - Red Ch.
3	From Driver's Control Panel Jct. 3 to Reverse Solenoid Magnetic Switch	14	Blk. - 2 Red // Tr.
4	From Terminal #2 Hot Engine and Low Oil Relays to Driver's Control Panel Junction 4	16	Grn. - Blk. Tr.
5	Engine Alarm:		
	From Driver's Control Panel Junction 5	16	Grn. - Nat. Cr. Tr.
	To Engine Oil Pressure Sending Unit	16	Blk.
6	From Driver's Control Panel Jct. 6 to Rear Marker Lamps	14	Brn. - Blk. Tr.
7	From Engine Harness Connector Contact 10 to Driver's Control Panel Junction 7	16	Blk.
8	*Lavatory Mirror Circuit:		
	*From Battery Compartment Apparatus Box	16	Or.
	*To Lavatory Mirror Lamps	16	Blk.
9	*Fire Detector Circuit:		
	*From Engine Harness Connector Contact 11	16	Blk.
	*To Driver's Control Panel Junction 9	16	Grn. - 2 Red // Tr.
10	Tail Lamps Circuit:		
	From Driver's Control Panel Junction 10 to Engine Compartment Door Connector Junction 4	16	Brn.
11	Stop Lamp Circuit:		
	From Driver's Control Panel Junction 11	16	Red - 2 Nat. // Tr.
	To Engine Compartment Door Connector Jct. 6	16	Red
12	Open		
13	From Driver's Control Panel Junction 13	16	Blk. - Red Tr.
	To Engine Harness Connector Contact 5	16	Blk.
14	Engine Alarm - Hot Engine Circuit:		
	From Driver's Control Panel Junction 14	16	Grn. - 2 Nat. // Tr.
	To Hot Engine Relay Terminal 3	16	Grn. - 2 Nat. // Tr.
	To Engine Harness Connector Contact 6	16	Blk.
15	From Driver's Control Panel Junction 15	16	Grn. - Blk. Cr. Tr.
	To Engine Harness Connector Contact 7	16	Blk.
16	Open		
17	Speedometer Circuit:		
	From Driver's Control Panel Junction 17	16	Blk. - 2 Nat. // Tr.
	To Engine Harness Connector Contact 9	16	Blk.
18	Open		
19	From Driver's Control Panel Jct. 19 to Engine Rear Start Switch	14	Grn. - 2 Brn. // Tr.
20	Spare (To Driver's Control Panel Jct. 20)	16	Or. - 2 Blk. // Tr.
21	R.H. Rear Directional Lamp Circuit:		
	From Driver's Control Panel Junction 21	16	Red - 2 Grn. // Tr.
	To Engine Compartment Door Connector Jct. 1	16	Dk. Grn.
22	From Driver's Control Panel Junction 22	14	Grn.
	To Engine Control Switch Stop Solenoid Valve	16	Grn.
	*To Engine Stop Relay	14	Grn.
23	*Automatic Engine Stop Circuit:		
	*From Driver's Control Panel Junction 23	14	Grn. - Red Tr.
	*To Engine Control Switch	16	Grn.
24	From Driver's Control Panel Junction 24	16	Grn. - 2 Nat. // Tr.
	To Low Oil Pressure Switch (Engine)	16	Blk.
	To Low Oil Relay Terminal 3	16	Grn. - 2 Nat. // Tr.
25	From Driver's Control Panel Junction 25	16	Grn. - Nat. Tr.
	To Fast Idle Solenoid Valve	16	Blk.
26	Open		
27	*Speedometer Circuit:		
	To Driver's Control Panel Junction 27	16	Blk. - Grn. Tr.
28	Water Pump Switch to Circuit Breaker 4	16	Yell.
29	From Driver's Control Panel Junction to Engine Rear Start Switch	14	Grn. - Brn. Cr. Tr.
30	Spare (To Driver's Control Panel Junction 30)	16	Blk. - Red Cr. Tr.

*Special Equipment.

Continued on next page.

ENGINE COMPARTMENT APPARATUS BOX JUNCTIONS (CONT'D)

Terminal No.	Circuit	Wire Size	Color Code
31	L.H. Rear Directional Lamp Circuit:		
	From Driver's Control Panel Junction 31	16	Red - Grn. Cr. Tr.
	To Engine Compartment Door Connector Junction 3 . .	16	Yell.
32	Engine Compartment Lamps Circuit:		
	From Engine Compartment Lamp Switch	16	Brn.
	To Engine Compartment Lamps	16	Blk.
33	Water Pump Circuit:		
	From Water Pump Switch	16	Yell. - Red Tr.
	To Battery Compartment Junction 2R	16	Yell. - Red Tr.
34	Spare (To Battery Compartment Junction 6R)	14	Blk. - Brn. Cr. Tr.
35	Ground		
36	Spare (To Driver's Control Panel Junction 36)	16	Blk. - 2 Red // Tr.
37	*Speedometer Circuit:		
	To Driver's Control Panel Junction 37	16	Blk. - 2 Grn. // Tr.
38	Air Conditioning Circuit:		
	From Oil Pressure Switch	14	Blk.
	To Air Conditioning Clutch Solenoid & Control Valve . .	14	Yell. - Blk. Tr.

*Special Equipment.

ENGINE COMPARTMENT APPARATUS BOX CIRCUIT BREAKERS

Circuit breaker carrier (fig. 6) has space for six automatic-reset type circuit breakers. On coaches with standard electrical equipment, only three circuit breakers are used. The other circuit breakers may be used with special electrical equipment. Operation of circuit breakers is described previously under "Driver's Control Panel Circuit Breakers."

Circuit breaker numbers shown on Wiring Diagrams and in the tabulation which follows do not appear on the circuit breakers or on the panel. To identify circuit breakers refer to the diagram shown in figure 6.

The following tabulation lists each circuit breaker number (as identified in figure 6), the circuit it protects, and the size, color, and pattern of the wire (or wires) which connect to each circuit breaker terminal.

To help prevent unnecessary trouble to driver while on the road, make sure all terminal junctions are kept clean and tight.

When replacing circuit breakers, make sure the proper amperage rating circuit breaker is used.

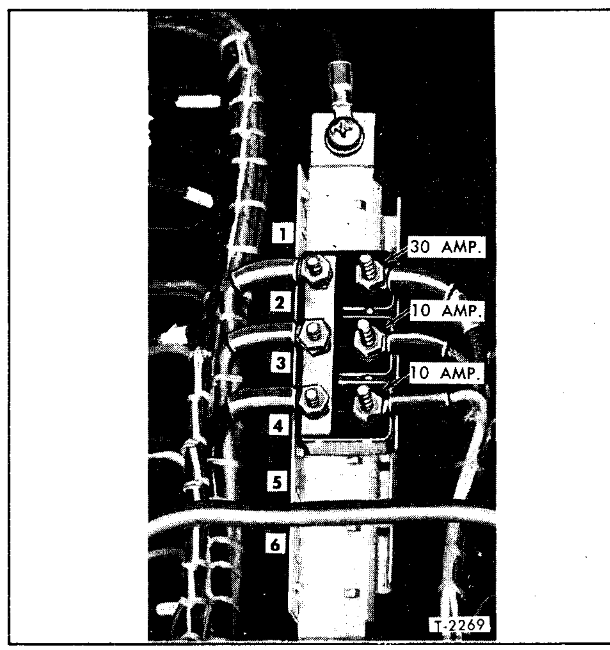
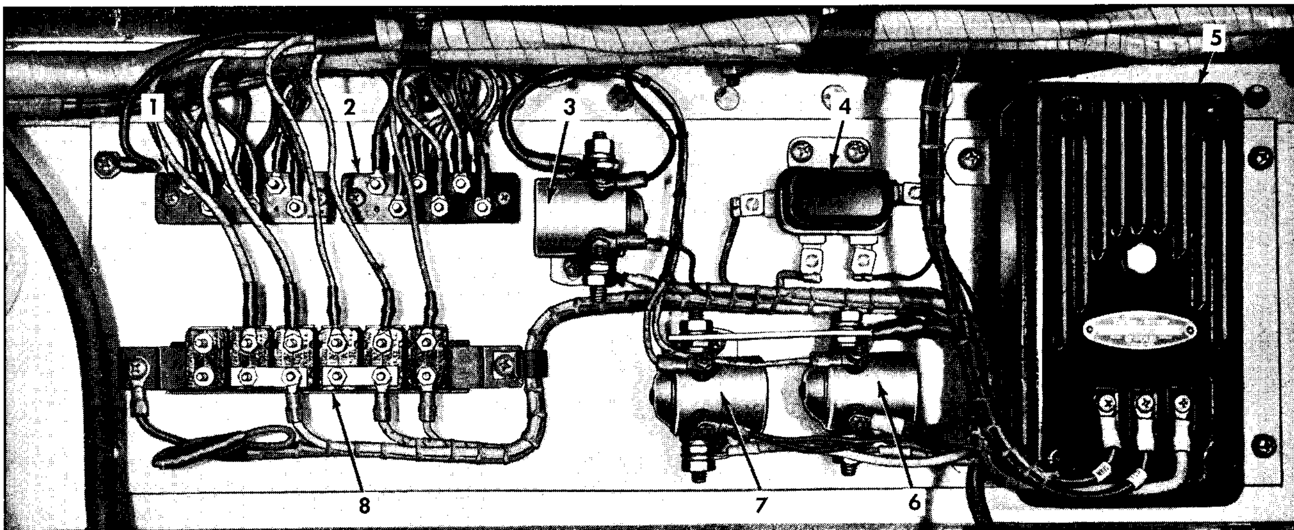


Figure 6—Engine Compartment Apparatus Box Circuit Breakers

Breaker No.	Circuit	Wire Size	Color Code	Fed From
1	Open			
2	To Reverse Solenoid Magnetic Switch . .	10	Blk. - Grn. Tr.	Battery
3	To Engine Compartment Lamp Switch . .	16	Brn.	Battery
4	Water Pump Circuit to Junction 28 . . . . in Apparatus Box	16	Yell.	Battery
5	Open			
6	Open			

BATTERY COMPARTMENT APPARATUS BOX

Battery compartment apparatus box (fig. 7) is located in left rear baggage compartment above the battery compartment. Access to components is attained by removing shield mounted on top of battery compartments. Components installed in battery compartment apparatus box are identified in figure 7.



1 Left Junction Block
2 Right Junction Block
3 Regulator Magnetic Swi*ch
4 Generator Relay
5 Voltage Regulator Assembly
6 General Lighting Magnetic Switch
7 Reading Lamps Magnetic Switch
8 Circuit Breakers

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Figure 7—Battery Compartment Apparatus Box

BATTERY COMPARTMENT APPARATUS BOX JUNCTION BLOCKS

Two junction blocks in battery compartment apparatus box are each numbered from 1 through 6. Junction terminal numbers shown on Wiring Diagrams and in tabulation appear on the junction blocks. The letters "L" and "R" used with the terminal numbers identify the left and right junction block.

The tabulation which follows lists each terminal number, the circuit it carries, and the size, color, and pattern of the wires which connect to the terminal. A similar tabulation printed on a card is attached to a wiring harness in the battery compartment. Some of the unused terminals, marked "open" or "spare" in the tabulation, may be used for special electrical equipment. Terminal post numbers on junction blocks appear on Wiring Diagram in the symbol ◇.

Terminal No.	Circuit	Wire Size	Color Code
1L	*From Lavatory Switch to Engine Comp't. Apparatus Box Junction 8	16	Or.
2L	*From Driver's Control Panel Junction 39 to Lavatory Emergency Switch	16	Blu. - Nat. Tr.
3L	*From Driver's Control Panel Jct. 38 to Lavatory Switch	14	Blu. - Nat. Cr. Tr.
4L	*From Lavatory Switch	14	Blu.
	To Lavatory Vent Fan	14	Blk.
5L	From Driver's Control Panel Junction 6	14	Brn. - Blk. Tr.
	To Rear Nite Lamp	16	Blk. - Red Tr.
6L	From Driver's Control Panel Jct. 46 to Air Conditioning Hi-Lo Pressure Switch Terminal MI	16	Yell. - Blk. Cr. Tr.
1R	*Rear Wheel Sander Circuit:		
	*From Driver's Control Panel Junction 54	10	Red - Grn. Tr.
	*To Rear Wheel Sanders	10	Nat.
2R	From Circuit Breaker 6 to Engine Comp't. Apparatus Box Junction 33	16	Yell. - Red Tr.

*Special Equipment.

BATTERY COMPARTMENT APPARATUS BOX JUNCTION BLOCKS (CONT'D)

Terminal No.	Circuit	Wire Size	Color Code
3R	From Driver's Control Panel Junction 45 to Air Conditioning Hi-Lo Pressure Switch Terminal L2 . . .		Yell. - 2 Red // Tr.
4R	From Driver's Control Panel Junction 51	16	Nat. - Blk. Cr. Tr.
	To Seat Lamps	16	Blk. - Grn. Tr.
5R	From Air Conditioning Hi-Lo Pressure Switch Terminal M2 to Hydraulic Fan Solenoid Valve	14	Yell. - Grn. Tr.
6R	Spare (To Ventilation Compartment Junction 3)	16	Blk. - Br. Tr.
	(To Engine Compartment Apparatus Box Jct. 34) . .	14	Blk. - Brn. Cr. Tr.

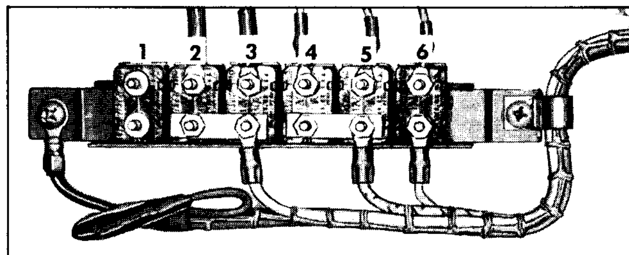
*Special Equipment.

BATTERY COMPARTMENT APPARATUS BOX CIRCUIT BREAKERS

Circuit breakers are accessible after removing shield mounted on top of battery compartment. Operation of circuit breakers is described previously under "Driver's Control Panel Circuit Breakers."

Circuit breaker numbers shown on Wiring Diagrams and in the tabulation which follows do not appear on the circuit breakers or on the panel; to identify circuit breakers, it is necessary to refer to diagram shown in figure 8.

The following tabulation lists each circuit breaker number (as identified in figure 8), the circuit it protects, and the size, color, and pattern of the wire (or wires) which connect to the circuit breaker terminals.



1 10-Amp
2 30-Amp
3 30-Amp
4 20-Amp
5 20-Amp
6 20-Amp

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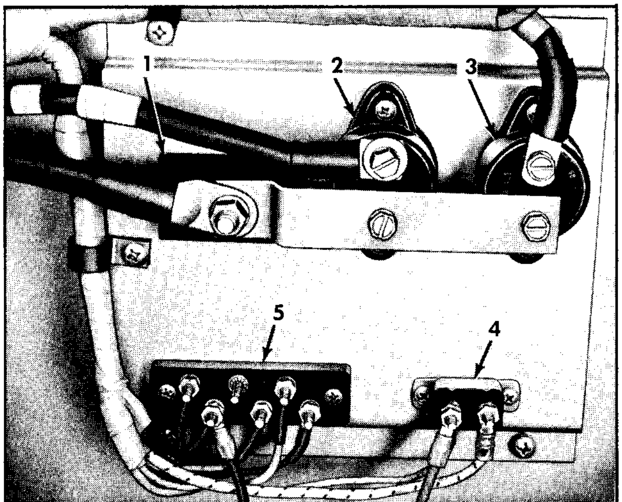
Figure 8—Battery Compartment Circuit Breakers

Breaker No.	Circuit	Wire Size	Color Code	Fed From
1	*From Lavatory Emergency Switch	14	Blu. - Red Tr.	
	To Reading Lamp Magnetic Switch	14	Red	Battery
2	From Reading Lamp Magnetic Switch . . .	10	Nat.	Reading Lamp
	To L.H. Reading Lamps and Switches . .	10	Nat. - Red Tr.	Magnetic Sw.
3	From Reading Lamp Magnetic Switch . . .	10	Nat.	Reading Lamp
	To R.H. Reading Lamps and Switches . . .	10	Nat. - Red Tr.	Magnetic Sw.
4	From General Lamp Magnetic Switch . . .	10	Nat. - Grn. Cr. Tr. . . .	Gen. Lamp
	To L.H. General Lamps	14	Nat. - Blk. Tr., ...	Magnetic Sw.
5	From General Lamp Magnetic Switch . . .	10	Nat. - Grn. Cr. Tr. . . .	Gen. Lamp
	To R.H. General Lamps	14	Nat. - Blk. Tr.	Magnetic Sw.
6	From Generator Relay Terminal 2 to Driver's Control Panel Junction 42 . .	14	Gray	Generator Relay

*Special Equipment.

VENTILATION COMPARTMENT APPARATUS PANEL

Ventilation compartment apparatus panel is located in the ventilation compartment on the lower right-hand air duct plate assembly. Components of the ventilation compartment apparatus panel are identified in figure 9 on next page.



1 Battery Junction Block
2 Circuit Breaker (90 Amps)
3 Circuit Breaker (135 Amps)
4 Circuit Breaker (20 Amps)
5 Terminal Junction Block (1 thru 6)

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Figure 9—Ventilation Compartment Apparatus Panel

VENTILATION COMPARTMENT JUNCTION BLOCK

Ventilation compartment junction block contains terminal posts numbered 1 through 6. Numbers on block correspond to numbers on Wiring Diagrams and in tabulation which follows. The tabulation lists each terminal number, the circuit it carries, and the size, color, and pattern of the wires which connect to the terminals. Terminal post numbers on junction block appear on Wiring Diagrams in the symbol ◇ .

Terminal No.	Circuit	Wire Size	Color Code
1	Spare (To Driver's Control Panel Jct. 56)	16	Blk. - Nat. Cr. Tr.
2	*Fuel Gauge Circuit:		
	Spare (To Driver's Control Panel Jct. 55)	16	Or. - Grn. Tr.
3	Spare (To Battery Compartment Jct. 3)	16	Blk. - Brn. Tr.
4	To Driver's Control Panel Jct. 44 and Blower Motors Magnetic Switch	14	Yell.
5	Open		
6	From Water Pump to Ground	14	Blk.

*Special Equipment.

VENTILATION COMPARTMENT CIRCUIT BREAKERS

Operation of circuit breakers is described previously under "Driver's Control Panel Circuit Breakers."

The following tabulation lists each circuit breaker (as identified in figure 9), amperage rating, the circuit it protects, and the size, color, and pattern of the wire (or wires) which connect to each circuit breaker terminal.

Breaker No.	Circuit	Wire Size	Color Code	Fed From
90 Amp.	To Bus Bar in Driver's Control Panel	1	Red	Battery
135 Amp.	To Blower Motors Magnetic Switch	2	Red	Battery
20 Amp.	From Battery Compartment Junction 2R	16	Yell. - Red Tr.	
	To Water Pump		Red	
	To Electronic Heat Unit	10	Yell. - Red Tr.	

AMPHENOL CONNECTORS

Wiring harness connections are made at several points on vehicle through Amphenol multiple plug and receptacle type connectors. Terminals in receptacle and on plug are identified by numbers. Locating key in receptacle housing engages a slot in plug to assure proper installation of plug. Numbers on plugs and receptacles correspond to numbers shown on Wiring Diagrams and in the tabulations which follow. Location of each Amphenol connector, together with the symbols and circuit tabulations, follows:

ENGINE AMPHENOL CONNECTOR

Electrical connections between the terminals, circuit breakers and electrical units in engine compartment apparatus box and the engine wiring harness are made through the receptacles at right side of the engine compartment apparatus box. Refer to symbol ⬡ on Wiring Diagram.

Terminal No.	Circuit	Wire Size	Color Code
1	From Circuit Breaker 4 to Starter Solenoid	10	Blk.
2	From Reverse Solenoid Magnetic Switch	10	Blk. - Grn. Tr.
	To Reverse Solenoid	10	Blk.
3	From Emerg. Stop Magnetic Sw. to Emerg. Stop Solenoid	10	Blk.
4	From Starter Magnetic Switch to Starter Solenoid	10	Blk.
5	From Engine Compartment Apparatus Box Junction 13 to Transmission Oil Pressure Switch	16	Blk.
6	From Engine Compartment Apparatus Box Junction 14 to Hot Engine Switch	16	Blk.
7	From Engine Compartment Apparatus Box Junction 15 to Engine Temperature Sending Unit	16	Blk.
8	From Starter Magnetic Sw. to Fuel Pressure Sw.	14	Blk.
9	From Engine Compartment Apparatus Junction 17 to Speedometer Sending Unit	16	Blk.
10	From Engine Compartment Apparatus Junction 7 to Speedometer Sending Unit	16	Blk.
11	*From Engine Compartment Apparatus Junction 9 to Fire Detectors	16	Blk.

*Special Equipment.

ENGINE CLOSURE DOOR AMPHENOL CONNECTOR

Engine compartment closure door wiring harness, carrying circuits to lights on door, is connected to amphenol connector on rear body wiring harness assembly. Refer to symbol ⊠ on Wiring Diagram.

Terminal No.	Circuit	Wire Size	Color Code
1	From Engine Compartment Door Connector Junction 1 to R.H. Rear Directional Lamps	16	Dk. Grn.
2	Ground	16	Blk.
3	From Engine Compartment Door Connector Junction 3 to L.H. Rear Directional Lamps	16	Yell.
4	From Engine Compartment Door Connector Junction 4 to Tail Lamps	16	Brn.
5	Open		
6	From Engine Compartment Door Connector Junction 6 to Stop Lamps	16	Red

BATTERY JUNCTIONS

Battery junctions are located in several places on the vehicle. Battery cables, carrying current to various parts of the vehicle for operation of the electrical units and systems, are connected at these junctions. Connections must be kept clean and tight. If corroded, disconnect cables and thoroughly clean cable ends and junction studs. Reconnect cables to junction studs and tighten stud nuts firmly. Locations of battery cable junctions are as follows:

1. Battery compartment junction (fig. 7), located on wall of rear baggage compartment above battery compartment, is accessible after removing guard mounted on top of battery compartment.
2. Engine compartment apparatus box (fig. 5) battery junction, located approximately in center of the upper engine compartment bulkhead, is accessible through the engine compartment doors.
3. Ventilation compartment apparatus box battery junction, located on lower right-hand air duct plate assembly, is accessible through the evaporator compartment door.
4. Driver's control panel battery junction, located at the bottom of junction panel at left of driver (fig. 3), is accessible after the junction panel cover is removed.

TELL-TALE ALARM SYSTEM

TELL-TALE LIGHTS

Tell-tale lights are located on gauge and tell-tale panel in front of driver (fig. 1). Tell-tale identification, shown in figure 1, is visible only when the light bulb under the lettering is illuminated. Following is a list of all tell-tale lights with a brief description of their purpose and a reference to the Wiring Diagram on which the circuit is shown.

1. "HOT ENG." Tell-tale, interconnected with the alarm buzzer, indicates that the temperature of the engine is too high for safe operation. Engine should be stopped immediately and the overheated condition corrected. Circuit is shown on "Alarm and Signal Wiring Diagram." Refer to "NOTE" following step 2 below.
2. "LOW OIL." This tell-tale, interconnected with the alarm buzzer, indicates that the engine lubricating oil pressure is below 3 psi. If tell-tale illuminates and buzzer sounds during operation, stop engine immediately and correct the cause of low oil pressure. Electrical circuit is shown on "Alarm and Signal Wiring Diagram." Refer to "NOTE" below:

NOTE: On vehicles equipped with special automatic engine shut-off system, the "HOT ENG." and "LOW OIL" tell-tale circuits are interconnected with a safety control relay which automatically shuts off the engine when either one of these abnormal conditions occur.

This condition can be overruled by pressing "Over-Rule" switch located on instrument panel. Operation of Automatic Engine Stop System is described later in this section.

3. "LOW AIR." This tell-tale, interconnected with the alarm buzzer, indicates that air pressure is below 55-60 psi. This pressure will not efficiently operate brakes and air suspension system. If tell-tale illuminates and buzzer sounds during operation, stop the vehicle as soon as possible and correct the cause of low air pressure before proceeding. Refer to "Alarm and Signal Wiring Diagram."

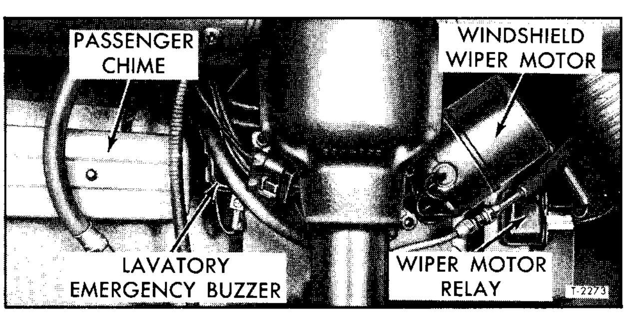


Figure 10—Windshield Wiper Motor, Lavatory Emergency Buzzer, and Chime Unit Installation

4. "TRANS. OIL." This tell-tale indicates low oil pressure in the transmission. Electrical circuits and connections are shown on "Transmission Wiring Diagram."
5. "A.C. STOP." This tell-tale will illuminate when the refrigerant "Hi-Lo" pressure switch contacts are open, indicating that the compressor drive clutch is disengaged. Refer to "Heating and Air Conditioning Wiring Diagram."
6. "HAND BRAKE." This tell-tale will illuminate when the parking brake is applied and "Engine" switch is in "RUN" position. Electrical circuits and connections are shown on "Engine Control and Generator Wiring Diagram." Refer to "Alarm and Signal Switches" for parking brake switch operation and adjustment.
7. "STOP LAMP." This tell-tale illuminates when brakes are applied to indicate normal functioning of stop lights. If tell-tale does not illuminate when brakes are applied, it is an indication that one or both stop light bulbs are burned out. Refer to "Alarm and Signal Wiring Diagram."
8. "HI-BEAM." This tell-tale illuminates when headlight high beam is being used. Refer to "Coach Lighting Wiring Diagram."
9. "DIRECT SIG." These tell-tale lamps, located at each end of "tell-tale" lamp cluster, flash on and off when directional signals are being used to indicate normal functioning of signals. Failure of either tell-tale lamp indicates a burned out directional signal lamp or defective flasher unit. Electrical circuits are shown on "Stop and Directional Light Wiring Diagram."

ALARM BUZZER ASSEMBLIES (1116882)

HOT ENGINE, LOW OIL, AND LOW AIR ALARM BUZZERS

Alarm buzzer assemblies are mounted in driver's control panel junction box at left of driver (items 10 and 11, fig. 3). Tell-tale lamps "Hot Eng." and "Low Oil" are interconnected with alarm buzzer (item 10), and "Low Air" with alarm buzzer (item 11). Circuits can be checked for continuity, referring to "Alarm and Signal Wiring Diagram." The "Engine" switch must be in "RUN" position to energize the circuits. When checking circuits, sending unit switches must be grounded. If buzzer is found to be defective, replace unit.

LAVATORY EMERGENCY ALARM BUZZER

Alarm buzzer is mounted under left side of instrument panel (fig. 10). Buzzer is operated by

a push-button type switch, marked "TO SIGNAL DRIVER - EMERGENCY ONLY," located on transverse partition of lavatory compartment. Refer to "Lavatory Wiring Diagram" in back of manual for wiring connections and circuits. When checking circuit for continuity, the "ENGINE" switch must be in the "RUN" position to energize system and switch in lavatory compartment must be grounded. If buzzer is found to be defective, replace unit.

ALARM AND SIGNAL SWITCHES

Low oil pressure switch, engine overheat thermostat, transmission oil, air conditioner stop, and low air pressure switch are covered in other sections of this manual as previously indicated under "Index of Electrical Units."

PARKING BRAKE TELL-TALE SWITCH

Parking brake tell-tale switch, mounted under floor near driver's seat, is used to complete parking brake tell-tale light circuit. Electrical connections for parking brake tell-tale system are shown on "Engine Control and Generator Wiring Diagram." Maintenance of parking brake switch is covered in BRAKES (SEC. 4).

STOP LIGHT, DIRECTIONAL SIGNAL, AND HEADLIGHT DIMMER SWITCHES

Tell-tale lamps for stop lights, directional signals, and headlight high beams are connected directly to switches which control individual circuits. Refer to "LIGHTING SYSTEM" in this section for maintenance and location of switches.

ENGINE AUTOMATIC SHUT-OFF SYSTEM

The air-operated injector shut-off system stops the engine when "ENGINE" switch is in "STOP" position. Operation and maintenance of this system is covered in "DIESEL ENGINE" (SEC. 8).

On some coaches, an automatic engine shut-off relay system is used in conjunction with the air-operated injector shut-off system. This system is used in conjunction with the low oil pressure and hot engine tell-tale alarm system and the air-operated injector shut-off system to automatically stop the engine when a low oil pressure or hot engine condition occurs. Low oil and hot engine tell-tale circuits are mounted in the Driver's Control Panel (fig. 3). Hot engine, low oil, and engine stop relays are mounted in Engine Compartment Junction Panel (fig. 5). These units are connected into electrical system as shown on "Engine Control and Generator" and "Alarm and Signal" wiring diagrams.

The engine stop relay, with points normally closed, is fed from "ENGINE" run magnetic switch. Current for energizing engine stop solenoid valve, which must be energized while engine is running, is fed through normally closed points of engine stop relay. Relay operating coil is connected to low oil pressure and engine overheat relays.

When low oil pressure switch or engine overheat thermostat contacts close, circuit is completed through low oil relay or hot engine relay to engine stop relay operating coil. With relay operating coil energized, relay contacts open, breaking circuit to engine stop solenoid valve. With solenoid valve de-energized, air pressure is admitted to engine shut-off air cylinder. The action of air cylinder on engine governor moves injector racks to no-fuel position, stopping engine.

AUTOMATIC ENGINE SHUT-OFF SYSTEM TEST

Start engine and run for a few minutes to build up air pressure in system. Ground the engine overheat thermostat terminal to complete the circuit through the hot engine relay and engine stop relay operating coil. Engine stop solenoid valve should open and admit air to engine shut-off air cylinder on governor, moving the injector racks to no-fuel position, thus shutting off the engine. If engine does not stop, check operation of engine stop solenoid valve and air cylinder before condemning the engine stop relay. Refer to "Relays" described later in this section for operation and maintenance of relays.

ENGINE "STOP OVERRULE" SWITCH

Coaches equipped with automatic engine shut-off system also have an overrule switch, located at top left of driver's instrument panel. Overrule switch is a momentary-on type switch. This switch must be held in for "On" position and returns to "Off" position when released. Purpose of switch is to feed current to the engine stop solenoid valve, overruling the engine stop relay. This permits starting the engine and moving the coach to safety in case the automatic shut-off system shuts off the engine.

Electrical connections for "Stop Overrule" switch are shown on "Engine Control and Generator" Wiring Diagram.

RELAYS

Relays are used in some instances to automatically open or close a circuit as operating conditions may require; in other cases they are used to provide a direct connection between the battery and an electrically operated device, with only a small amount of current required to energize the relay operating coil flowing through the controlling switch. The latter use eliminates the use of great lengths of heavy wire, thereby providing higher voltage to the electric device. Several of the same type relays are used on each vehicle; however, they are used in different circuits for different purposes.

Location, operation, and adjustment of various types of relays are described later under individual headings. Before attempting adjustment of relays, make sure points are clean. Clean contact points with a thin, fine-cut file if pitted or burned. Refer to applicable Wiring Diagrams for relay circuits.

The following tabulation lists each relay used, its location on the vehicle, and its part number. After determining part number of relay, refer to instructions under that part number for operation and adjustment.

Relay	Location	Part No.
Air Conditioner Control	A/C Compressor Comp't. (Sect. 26)	1116969
Blower Motor	Heating and Ventilation Comp't. (Sect. 26)	2482373
Emergency Stop	Engine Comp't. Panel (6, fig. 5)	1114223
Engine Run	Driver's Control Panel (8, fig. 3)	1114223
Engine Stop	Engine Comp't. Jct. Panel (3, fig. 5)	1115836
General Lamp	Battery Comp't. Jct. Panel (6, fig. 7)	1114223
Generator Switch	Battery Comp't. Jct. Panel (4, fig. 7)	1114223
Generator	Driver's Control Panel (9, fig. 3)	1116967
Horn	Driver's Control Panel (5, fig. 3)	1116969
Hot Engine	Engine Comp't. Jct. Panel (7, fig. 5)	1116969
Low Oil	Engine Comp't. Jct. Panel (8, fig. 5)	1116969
Pilot	Under Dash - Right-Hand Side (fig. 10)	2465846
Reading Lamp	Battery Comp't. Jct. Panel (7, fig. 7)	1114223
Regulator Sensing	Battery Comp't. Jct. Panel (3, fig. 7)	1114223
Reverse Solenoid	Engine Comp't. Jct. Panel (4, fig. 5)	1114223
Starter	Engine Comp't. Jct. Panel (5, fig. 5)	1114223
Stop Lamp	Driver's Control Panel (6, fig. 3)	2465846
Watch Step Lamp	Under Dash - Right-Hand Side	1115826
Windshield Wiper	Wiper Motor Bracket (fig. 10)	1115826

RELAY 1114223 (MAGNETIC SWITCH)

Several of these relays are used on each vehicle as indicated in the "Relays" tabulation previously. Location and function of each relay are described under individual headings.

READING AND GENERAL LAMP RELAYS

Reading and general lamp relays are mounted on battery compartment junction panel (6 and 7, fig. 7). Electrical connections and circuits are shown on "Coach Lighting Wiring Diagram" in back of this manual.

Reading lamp relay "Bat" terminal is fed from battery compartment battery junction. Relay operating coil is energized from the "Reading" position of interior lighting switch. When operating coil circuit is completed, relay points close, completing circuit from battery to reading lamps.

General lamp relay "Bat" terminal is fed from battery compartment battery junction. Relay operating coil is energized from the "General" position of interior lighting switch. When operating coil circuit is completed, relay points close, completing circuit from battery to general lamps.

ENGINE RUN RELAY

Engine run relay is mounted on apparatus panel at left of driver (8, fig. 3). Electrical connections and circuits are shown on "Engine Control and Generator Wiring Diagram" in back of manual.

Engine run relay "Bat" terminal is fed from driver's control panel battery junction. Relay operating coil is energized from the "Run" position of engine "RUN" switch. When operating coil circuit is completed, relay points close, completing circuit from battery to driver's control panel bus bar which supplies current to starter switch, engine compartment controls, and lavatory wiring circuits.

GENERATOR SWITCH RELAY

Generator switch relay is mounted on apparatus panel at left of driver (9, fig. 3). Electrical

connections and circuits are shown on "Engine Control and Generator Wiring Diagram" in back of this manual.

Generator switch relay "Bat" terminal is fed from driver's control panel battery junction. Relay operating coil is energized from generator relay junction No. 2. When engine is running and generator is charging, generator relay switch operating coil circuit is completed, relay points close, and circuit is completed from battery to driver's control panel bus bar which supplies current to heating and ventilation control switches.

EMERGENCY STOP RELAY

Emergency stop relay is mounted on engine compartment apparatus panel (6, fig. 5). Electrical connections and circuits are shown on "Engine Control and Generator Wiring Diagram" in back of this manual.

Emergency stop relay "Bat" terminal is fed from engine compartment bus bar junction No. 3. Relay operating coil is energized by emergency stop switch located on driver's instrument panel. When operating coil circuit is completed, relay points close, completing circuit from battery to emergency stop solenoid which controls a choke valve to restrict air intake by engine.

STARTER RELAY

Starter relay is mounted on engine compartment apparatus panel (5, fig. 5). Electrical connections and circuits are shown on "Engine Control and Generator Wiring Diagram" in back of this manual.

Starter relay "Bat" terminal is fed from engine compartment bus bar junction No. 2. Relay operating coil is energized by starter switch located on driver's instrument panel. When operating coil circuit is completed, relay points close, and circuit is completed from battery to engine starter solenoid. Ground for relay operating coil is routed through contacts of fuel pressure switch, which are closed only when engine is not running. When engine starts and fuel pressure switch opens, operating coil of relay is de-energized and points open, breaking circuit to starter solenoid. Rectifier (9, fig. 5) mounted on starter relay prevents excessive arcing at contacts of fuel pressure switch.

REGULATOR SENSING RELAY

Regulator sensing relay is mounted on battery compartment junction panel (3, fig. 7). Electrical connections and circuits are shown on "Engine Control and Generator Wiring Diagram" in back of this manual.

Regulator sensing relay "Bat" terminal is fed from "DC" terminal on generator. Relay operating coil is energized from "Normal" position of engine starter switch, located on driver's instrument panel, through engine compartment junction No. 1. When operating coil circuit is completed, relay points close, and circuit is completed from battery to "P" terminal on voltage regulator which feeds current to "Field" circuit of generator.

REVERSE RELAY

Reverse relay is mounted on engine compartment apparatus panel (4, fig. 5). Electrical connections and circuits are shown on "Engine Control and Generator Wiring Diagram" in back of manual.

Reverse relay "Bat" terminal is fed from battery through engine compartment bus bar junction No. 2 30-Amp. circuit breaker. Relay operating coil is energized from reverse switch located on driver's instrument panel. When operating coil circuit is completed, relay points close, and circuit is completed from battery to reverse solenoid mounted on transmission which controls shift levers to permit engagement of reverse shift fork.

RELAY ADJUSTMENTS

These relays (magnetic switches) are sealed units and are not adjustable or repairable. If either switch fails to function properly, defective unit must be replaced.

RELAY 1115826

Three of these relays are used on each coach as indicated in the "Relays" tabulation previously. Location and function of each relay is described under individual headings. Relay test instructions apply to all three relays.

WATCH STEP LAMP RELAY

This relay is used in the watch step sign and night lamp flasher electrical circuits. Relay is mounted under instrument panel on right-hand heater and defroster panel. Refer to "Coach Lighting Wiring Diagram" in back of manual for electrical connections and circuits.

Relay terminal No. 1 is connected to watch step sign lamps and one night lamp located on second left-hand seat. Relay terminal No. 2 is connected to driver's apparatus panel junction No. 22 and completes circuit to illuminate sign and seat light from engine run magnetic switch. Relay activating coil terminal No. 4 is connected to entrance door switch and completes circuit, through flasher unit and relay terminal Nos. 3 and 1 when entrance door is opened, to flash watch step sign lamps and night lamp.

WINDSHIELD WIPER RELAYS

These two relays are used in the windshield wiper system. Relays are mounted, one on each windshield wiper motor bracket, as shown in figure 10. Electrical connections and circuits are shown

on "Windshield Wiper Wiring Diagram" in back of this manual.

The relays are a dual point type which control each circuit of the two-speed windshield wiper motors. Relay terminal No. 4 and wiper motor terminal No. 2 are fed from battery bus bar on driver's control panel through a 20-Amp. circuit breaker. Relay operating coil terminal No. 5 and contact point terminal No. 3 are grounded through "HI" side of windshield wiper switch. Relay contact point terminal No. 1 and wiper motor terminal No. 1 are grounded through "LO" side of windshield wiper switch. Relay contact point terminal No. 2 connects to wiper motor terminal No. 3. When wiper motor switch is placed in "LO" position, motor terminals No. 1 and No. 3 are grounded, through normally closed relay contact points, terminals No. 2 and No. 1, completing low speed circuit. When switch is placed in "HI" position relay operating coil is energized and contact points (No. 3 and No. 1) close, completing high speed circuit.

RELAY TEST

Connect voltmeter parallel with operating coil (No. 4 and No. 5 terminals). Connect variable resistance unit between No. 5 terminal and ground. Place engine "RUN" switch in "RUN" position. Slowly decrease resistance until relay activates and note reading on voltmeter. If opening voltage is not within limits listed in "Specifications," replace relay.

RELAY 1115836

This relay, used in the automatic engine shutoff system, is mounted on engine compartment apparatus panel (3, fig. 5). Relay connections and circuits are shown on "Engine Control and Generator Wiring Diagram" and "Alarm and Signal Wiring Diagram."

Relay "Bat." (No. 1) terminal is fed from driver's control panel bus bar terminal No. 2 through an 8-Amp. circuit breaker. Relay operating coil (No. 4) terminal is fed from hot engine and low oil relays through engine compartment apparatus panel junction No. 4. Relay operating coil (No. 3) terminal is grounded through hot engine and low oil relays (No. 2) terminal through engine compartment apparatus panel junction No. 1. When operating coil is energized, by either an engine overheat or low oil condition, points close. Current then flows from "Bat" (No. 2) terminal to engine stop solenoid valve through engine compartment apparatus junction No. 23, which shuts off fuel supply and stops engine.

RELAY TEST

Connect an accurate reading voltmeter parallel with operating coil circuit at terminals No. 3 and No. 4. Connect a variable resistance unit between coil circuit terminal No. 4 and ground. Start and run engine at fast idle (generator charging). Slowly decrease resistance until relay activates and note reading on voltmeter. If opening voltage is not within limits listed in "Specifications," replace relay.

RELAY 1116967

Generator relay is mounted on the battery compartment apparatus panel (4, fig. 7). Relay connections and electrical circuits are shown on "Engine Control and Generator Wiring Diagram" in back of manual.

Relay "Bat" (No. 1) terminal is fed from battery junction of reading lamp magnetic switch. Operating coil (No. 3) terminal is connected to "R" terminal of generator. When generator is charging, current is supplied from relay "R" terminal of generator through the operating coil of relay to ground terminal (No. 4). This action closes contact points to permit battery current to feed generator magnetic switch. This circuit is used to shut down heating and air conditioning system when generator is not charging.

RELAY TEST

Connect an accurate voltmeter parallel with operating coil at terminal No. 3 and No. 4. Connect a variable resistance in series with coil circuit at terminal No. 3. Start and run engine at fast idle (generator charging), slowly increase resistance until relay points open and note reading on voltmeter. If opening voltage is not within limits listed in "Specifications," replace relay.

RELAY 1116969

Several of these relays are used on each vehicle as indicated in the "Relay" tabulation previously. Location and function of each relay are described under individual headings. Test instructions apply to all units.

AIR CONDITIONING CONTROL RELAY

This relay is mounted on bulkhead in air conditioning compressor compartment (SEC. 26 - fig. 2). Refer to "Heating and Air Conditioning Wiring Diagram" in back of this manual for electrical circuits and connections.

Relay is a lock-in type unit; that is, after operating coil is energized and contacts close, contacts will remain closed as long as circuit through contacts is not broken. The purpose of the lock-in feature of air conditioning control relay is to maintain circuit to air condition solenoid valve after oil pressure safety switch opens.

Terminal No. 1 is fed from battery through

low air switch, "HI-LO" pressure switch, and A/C side of heating and air conditioning switch. Relay operating coil terminal No. 4 is fed through same circuit as above. Operating coil terminal No. 3 is grounded through oil pressure switch and relay contacts (No. 1 terminal).

HORN RELAY

This relay, used in the horn circuit, is mounted on apparatus panel at left of driver (5, fig. 3). Relay connections and circuits are shown on "Alarm and Signal Wiring Diagram" in back of manual.

Coil windings of relay (terminals No. 3 and No. 4) are connected in series with the horn button. When horn button is pressed, circuit through relay winding is completed and armature is attracted to core. This completes the circuit from the No. 1 terminal through the closed points and No. 2 terminal to the horn.

HOT ENGINE AND LOW OIL RELAYS

These relays, used in the engine shut down circuit system, are mounted on engine compartment apparatus panel (7 and 8, fig. 5). Relay connections and circuits are shown on "Alarm and Signal Wiring Diagram" and "Engine Control and Generator Wiring Diagram" in back of manual.

Operating coils of each relay are fed from battery through terminal No. 4. Operating coils of each relay are grounded through corresponding sensing switch located on engine. When either sensing switch closes, caused by a hot engine or low oil condition, circuit is completed through operating coils which close relay contact points. Contact points of relays (terminal No. 2) are connected in series with and activate engine alarm buzzer and automatic engine stop systems.

RELAY TEST

With all leads connected to the relay as shown on the applicable wiring diagram, connect an accurate reading voltmeter in parallel with the relay operating circuit at the No. 3 and No. 4 terminals. Insert a variable resistance unit in series with the operating coil circuit terminal. To check closing voltage, close the relay operating switch, then slowly decrease resistance until points close and note the voltage reading. (In some cases, generator must be charging to energize the relay operating circuits.)

If opening voltage is not within limits listed in "Specifications," replace relay.

RELAY 2465846—STANDARD (2474958—SPECIAL EQUIPMENT)

Three of these relays are used on coaches as standard equipment - stop lamp relay and two directional lamp pilot relays. Some coaches using additional directional signal lamps as special equipment substitute 2465846 with 2474958 relays to compensate for added bulbs. Location and function of relays are described under individual headings.

These relays are sealed units and are not adjustable or repairable. If relay fails to function properly, the defective unit must be replaced.

STOP LIGHT RELAY

This relay is used as a stop light tell-tale relay. Relay is mounted on apparatus panel at left of driver (6, fig. 3). Refer to "Alarm and Signal Wiring Diagram" in back of manual for electrical circuits and connections.

Relay is connected into the stop light and stop light switch circuit in such a manner that when the brakes are applied and stop light switch contacts close, current to stop lights passes through the relay coil winding. With coil winding energized, armature is attracted to core and relay points close, completing the circuit to the "STOP LAMP" tell-tale on instrument panel, indicating that the stop lights are illuminated.

Stop light tell-tale relay is sensitive to amperage, requiring the current draw of both stop light bulbs to close the points. If one bulb is burned out, current draw will not be sufficient to close the relay points, and "STOP LAMP" tell-tale will not illuminate when brakes are applied.

DIRECTIONAL SIGNAL PILOT RELAYS

These two relays are used as directional lamp tell-tale relays. Relays are mounted under instrument panel on right-hand heater and defroster panel (fig. 11). Refer to "Directional Lamp Wiring Diagram" in back of manual for electrical connections and circuits.

Relays are connected into the directional lamp switch circuit in such a manner that when the directional signal switch is placed in either right or left turn position, current to directional lamps passes through corresponding relay coil winding. With coil winding energized, armature is attracted to core and relay points close, completing circuit to "Directional Lamp" tell-tale on instrument panel, indicating that directional lamps are illuminated.

Directional lamp pilot relays are sensitive to amperage, requiring the current draw of both front and rear bulbs to close relay points. If one bulb is burned out, current draw will not be sufficient to close relay points, and "Directional Lamp" tell-tale will not illuminate.

Some coaches have extra side directional lamps as special equipment. These coaches use relay No. 2474958 which require the additional current draw of extra directional bulbs to operate relay points.

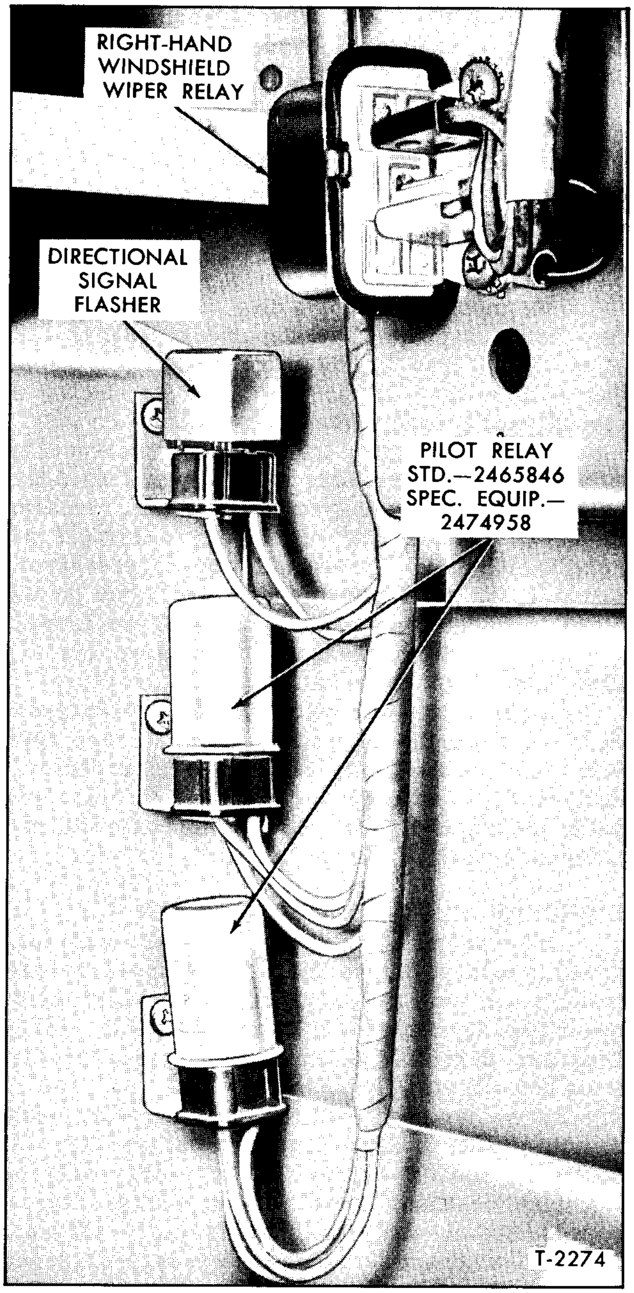


Figure 11—Directional Signal Flasher and Pilot Relays Installation

RELAY 2482373 (MAGNETIC SWITCH)

Two of these relays are used in the underfloor blower motor circuits. Refer to "HEATING AND AIR CONDITIONING" (SEC. 26) of this manual for location and operation of relays.

ELECTRIC HORNS

The two horns used on these coaches are electric air-tone "S" type. Each horn is carefully adjusted and inspected during manufacture and should operate indefinitely without attention. Horns are assembled with rivets and cannot be adjusted or repaired. If horn becomes defective, it must be replaced.

If horn fails to operate the trouble may be in the external circuit. Quick checks may be made with a jumper lead as follows:

1. Connect jumper lead from No. 3 terminal on horn relay to ground. If horn then operates, the trouble is in the horn control circuit. If horn does not operate remove jumper lead and proceed with step 2.

2. Momentarily connect jumper lead between No. 2 and No. 1 terminals on horn relay. If horn operates, the relay is defective and must be replaced.

3. Horn circuit is internally grounded through the horn mounting. Therefore, it is necessary that a good ground connection be maintained between the horn mounting bracket and its mating part. Check for a good ground by connecting a jumper lead from the horn bracket to the vehicle frame or grounded side of battery. Be sure contact is made through the paint of the horn bracket and frame.

After the above checks have been made and it is established that the horn is at fault, the trouble may be that the horn contacts are held open by a foreign particle. This condition can sometimes be corrected by energizing the horn, then lightly tapping the horn power plant to dislodge the particle.

ELECTRONIC SPEEDOMETER

OPERATION

A permanent magnet AC generator (sending unit) is mounted on the transmission and driven by transmission output shaft. Generator supplies a signal whose amplitude is proportional to its driven speed. This signal is rectified to direct current (DC), smoothed and fed to meter movement of speedometer, mounted on instrument panel (fig. 1), where it is read in M.P.H. Refer to "Speedometer Wiring Diagram" in back of manual for electrical connections and circuits.

MAINTENANCE

The following procedures for disassembly, testing, reassembly, and calibration of speedometer system are made after units are removed from the coach. Remove speedometer from instrument panel by disconnecting wiring harness and remove four nuts and lock washers securing speedometer to instrument panel and bracket. Disconnect wiring harness connector from terminal on transmission sending unit and remove sending unit from transmission.

TOOLS AND EQUIPMENT

Electrical equipment and small hand tools required to disassemble, test, and calibrate speedometer system are listed below:

1. Milliammeter with an internal resistance of 100 ohms ± 10 (Ideal Precision Meter Company Model 350 P-C or equivalent).
2. Variable resistor (10,000 to 100,000 ohms). If unable to obtain, purchase 0 to 100,000 resistor and place 10,000 resistor in series to prevent accidental meter burn-out.
3. 100 ohm fixed resistor to be used in series with milliammeter when testing circuit package.
4. Variable speed test stand (or a distributor test stand if available).
5. Small hand tools such as:
   a. No. 10 nut driver
   b. Medium blade screwdriver
   c. Small tipped, fast-heating, soldering iron
   d. Long nose pliers
   e. Tweezers

DISASSEMBLY (Fig. 12)

CAUTION: Work area must be clean and free of metal particles which could lodge in meter magnet.

1. Pry up and remove bezel, glass, gaskets and retainer. (Be careful not to allow metal particles to enter case.)
2. Remove nut and insulated washer from insulated stud at rear of case.
3. Remove number 10 nuts from speedometer assembly mounting and grounding studs at rear of speedometer case. Lift out meter movement and circuit package unit. (Do not misplace the insulating washer which insulates the insulating stud from inside case.)
4. Remove white meter lead from circuit board by unsoldering at "+" location on circuit board. Remove black meter lead from circuit board by unsoldering at "-" location on circuit board.
5. Remove two self-locking (circuit board to meter) retaining nuts from front side of circuit board and separate circuit board from meter movement.

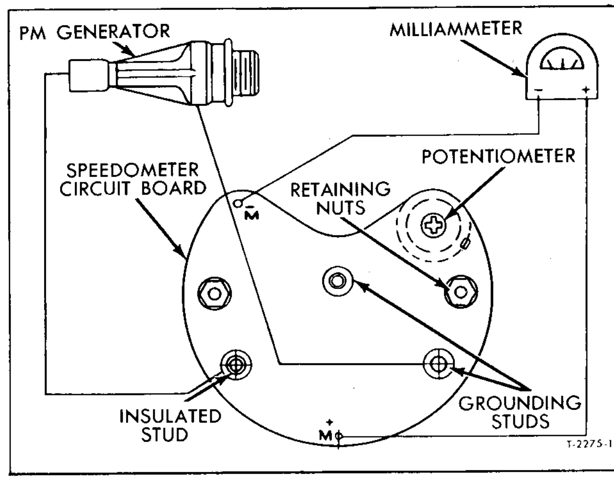


Figure 12—Speedometer System Units and Test Schematic

TESTS

Permanent Magnet (PM) Generator

PM generator is designed for rugged, long lived performance, with no requirements for field service. Special equipment is required to charge and calibrate special magnet. Bearings are lubricated for lifetime of generator. Check performance of unit as follows:

1. Remove key from drive end of generator and insert a short piece of speedometer cable.

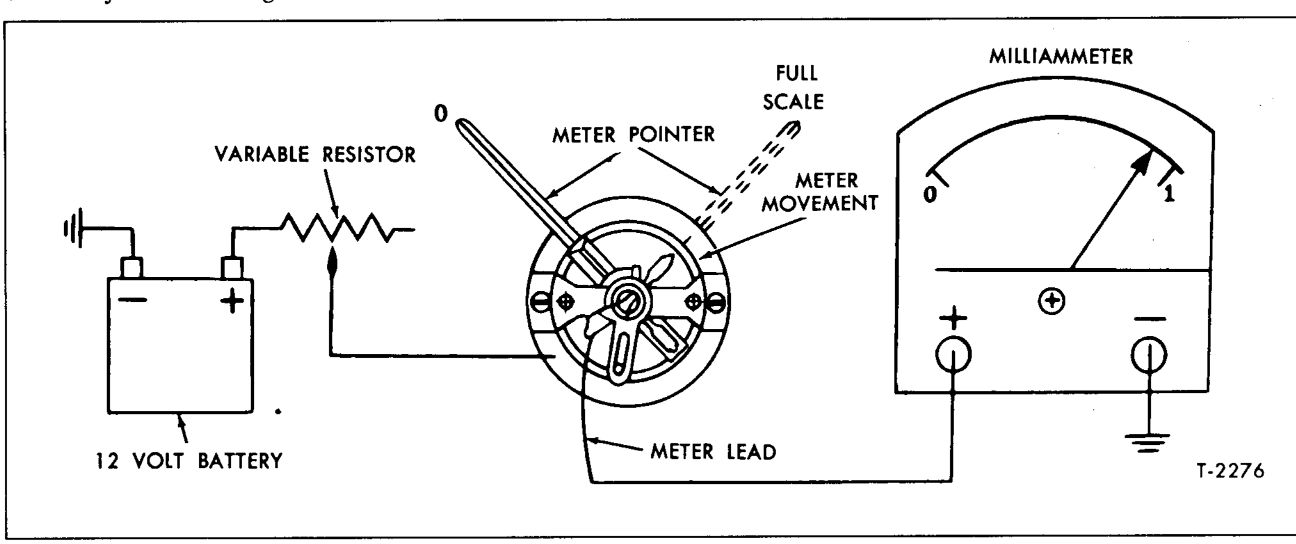


Figure 13—Speedometer Meter Movement Test Schematic

Connect other end of cable to a variable speed test stand. (An automatic service type distributor test stand may be used.)

2. Connect "+" lead from AC voltmeter (or a multimeter with selector set to measure AC voltage) to output terminal of generator. Connect "-" lead from voltmeter to frame of generator.

3. Drive generator by a test stand operating at 1000 R.P.M. The voltmeter should indicate 6 volts ± 5%. Increase test stand speed to 2000 R.P.M. The voltmeter should indicate 12 volts ± 5%.

4. If no voltage is shown, or value is above or below desired figure, generator should be replaced.

NOTE: If no defect is found, vehicle should be checked for a poor ground.

METER MOVEMENT (Fig. 13)

1. Set variable resistor to 100,000 ohm position.

2. Connect battery, variable resistor, meter movement and milliammeter as shown in figure 13.

WARNING: Do not accidentally short any part of test circuit to ground.

3. Speedometer meter movement is satisfactory if following readings are obtained under conditions described in A, B, and C.

A. Adjust variable resistor until:	B. Slowly adjust variable resistor to a lesser resistance to obtain a reading of 1 milliampere (full scale).	C. And speedometer should indicate 80 mph (full scale) ± 2 mph.
1. Speedometer indicates 20 mph.		
2. At which time milliammeter should indicate .20 ± 2.5%.		

Movement of pointer from 0 to full scale should be smooth and even throughout range of operation.

Sluggishness or unequal degree of movement could be caused by tangled hairsprings or improper end play. The end play is factory adjusted and should not be tampered with. Failure to obtain a reading would indicate open coils or hairspring connections. Any of above indications would require replacement of meter movement.

If the meter appears sticky, air gap and magnet surfaces should be examined for metal chips, lint, or dirt. These foreign particles may sometimes be removed with long tweezers. Quite often it is not possible to locate or extract offending particle and it is then necessary to replace meter movement.

CIRCUIT PACKAGE (Fig. 12)

1. Connect PM generator to test stand as directed in step 1. of permanent magnet generator test in this section.

2. Connect lead from PM generator to insulated terminal at front of circuit board.

3. Make remainder of connections as shown in figure 12. In addition, use a 100 ohm resistor in series with milliammeter during this test.

4. Run test stand at 60 mph (1001 rpm).

5. Speedometer circuit package is satisfactory if the following readings are obtained under conditions in a. and b. following:

a. Adjust potentiometer to provide a milliammeter indication of from 0 to .75.

b. Make final adjustment to provide a milliammeter indication of .73.

Action should be smooth throughout range of operation. If no milliammeter indication is possible, or erratic readings are obtained on milliammeter, circuit package should be replaced.

ASSEMBLY (Fig. 12)

1. Assemble meter movement to circuit board and install self-locking nuts.

2. Resolder white meter lead from meter movement to location marked "+" on circuit board.

3. Resolder black meter lead from meter movement to location marked "-" on circuit board.

4. Place insulating washer on insulated terminal at rear of case. Install the No. 10 retaining nuts and tighten.

5. Assemble glass, gaskets, and bezel to case and secure with tape until calibration has been completed.

CALIBRATION

1. Attach jumper wire from PM generator terminal to insulated terminal of speedometer and ground speedometer case to generator housing with jumper wire.

2. Drive generator at a steady test stand speed of 60 mph (1001 rpm).

3. Adjust speedometer potentiometer so that speedometer indicates 60 mph. Use a clean insulated screwdriver.

4. Vary test stand drive speed from 0 mph to 80 mph (1332 rpm). Speedometer indication should be smooth throughout range of operation.

5. Seal case potentiometer opening.

6. Remove tape from bezel and crimp bezel.

SPECIFICATIONS

CIRCUIT BREAKERS

Make....Spencer Thermostat or F. A. Smith Mfg. Co.
Type....Automatic Reset
Amperage Rating....Refer to figures 4, 6, and 8

MAGNETIC SWITCH

Make....Delco-Remy
Model....1114223
2482373
Voltage....12

ALARM BUZZER

Make....Delco-Remy
Model....1116882
Point Opening....0.017
Adjust to Buzz at....0.25-0.35 amps. at 13.5-14.5 volts

HORN

Make....Delco-Remy
Model....9000206
9000221
Voltage....12

Frequency
9000206....285
9000221....360

SPEEDOMETER

Make....AC Spark Plug Div.
Model....6412245

SPEEDOMETER DRIVE UNIT

Make....AC Spark Plug Div.
Model....6412933

RELAYS

1115826
Make....Delco-Remy
Air Gap (Points Closed)....0.011"
Point Opening....0.025"
Closing Voltage....8.3-10.2

1115836
Make....Delco-Remy
Air Gap (Points Closed)....0.030"
Point Opening....0.030"
Opening Voltage....7.8-10.2

1116967
Make....Delco-Remy
Air Gap (Points Closed)....0.011" min.
Point Opening....0.025"
Closing Voltage Range....4.5-5.2
Opening Voltage....0.3 min.
Sealing Voltage....5.6 max.

1116969
Make....Delco-Remy
Air Gap (Points Closed)....0.011" min.
Point Opening....0.025"
Closing Voltage Range....8.8-10.2
Opening Voltage....0.6 min.
Sealing Voltage....11.2 max.

2465846
Make....Tung-Sol Electric
Model....PR273
Voltage....12.8

2474958
Make....Tung-Sol Electric
Model....PR373
Voltage....12.8

Wiring Diagrams are bound in back of manual in MD number sequence.

Batteries

IMPORTANT - ELECTRICAL SYSTEM IS NEGATIVE GROUND.

GENERAL

Two 12-volt batteries, connected parallel, are mounted in the battery compartment box located in the rear baggage compartment. The battery cells are filled and checked through the two front access doors. Battery cables are accessible through the side access door. View of batteries installed is shown in figure 2. Battery compartment is vented through hole in bulkhead at top of compartment.

IMPORTANT: Observe decal on inside of battery compartment door which reads: CAUTION - NEGATIVE GROUND. It must be emphasized that if the batteries are not connected NEGATIVE GROUND, severe damage to the generator, regulator, batteries, and battery cables will result.

The battery has three major functions to perform on the vehicle:

1. It provides a source of current for starting the engine.
2. It acts as a stabilizer to the voltage in the electrical system.
3. It can for a limited time furnish current when the electrical demands of the electrical equipment exceed the output of the generator.

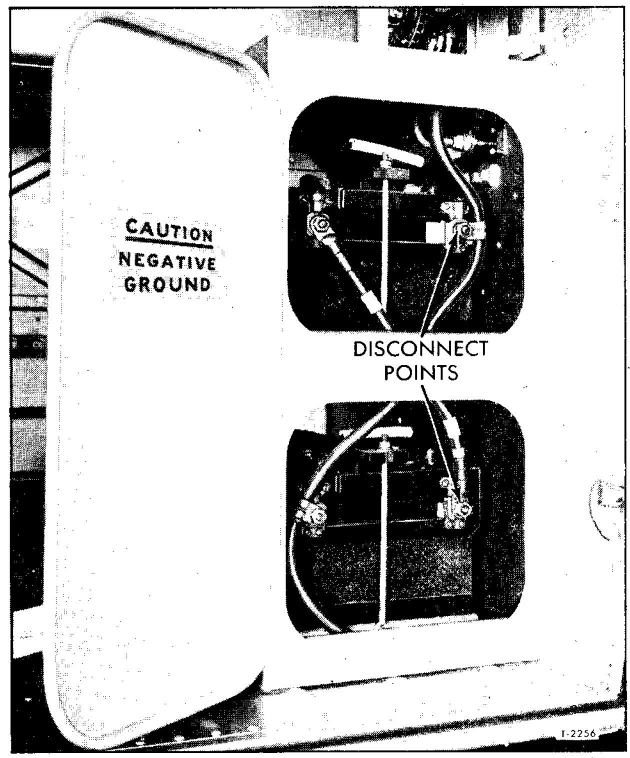


Figure 1—Battery Disconnect Points

BATTERY DISCONNECT

When it is necessary to remove battery power

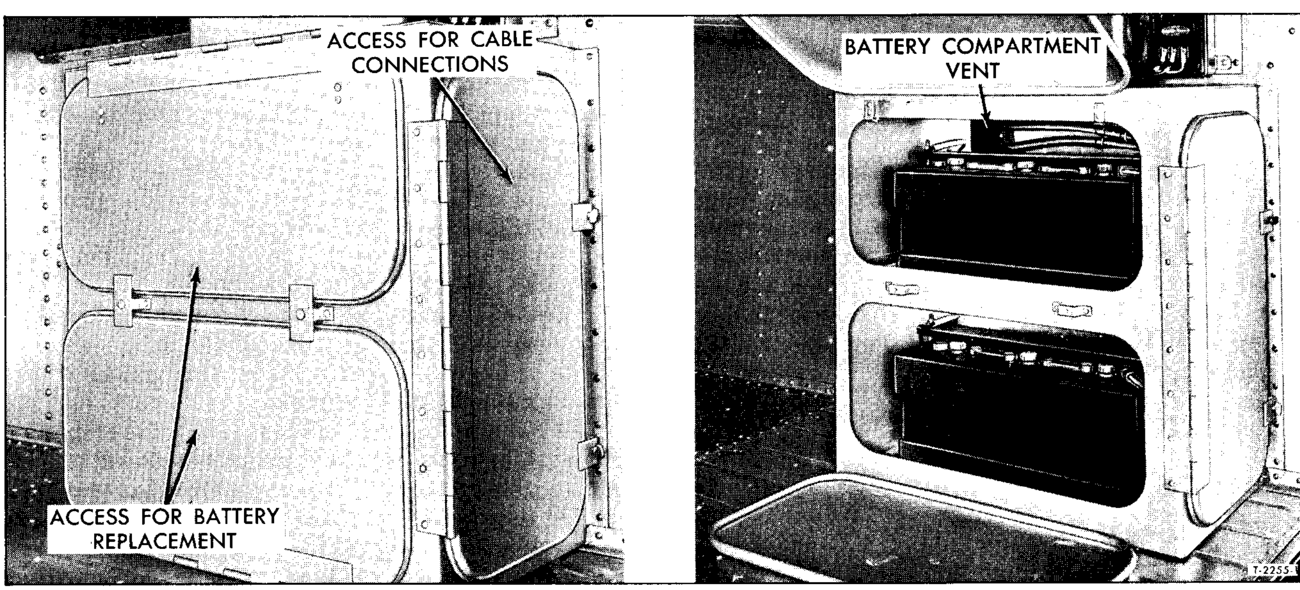


Figure 2—Batteries Installed

BATTERIES

from vehicle, disconnect battery positive (+) cables at points shown in figure 1.

CAUTION: After cables have been disconnected, wrap terminals with electrical tape or equivalent.

ON VEHICLE SERVICE

FILLING BATTERY

Electrolyte level in the battery should be checked at least every 1,000 miles or once every two weeks. If the electrolyte level is found to be low, water should be added to each cell until the level rises to the bottom of the vent well. DO NOT OVERFILL!

NOTE: Level of electrolyte can be checked by the use of a flashlight and mirror. Hold mirror over each cell opening and direct flashlight beam so electrolyte level can be seen.

Distilled water or water passed through a "demineralizer" should be used to eliminate the possibility of harmful impurities being added to the electrolyte. Many common impurities will greatly shorten battery life. DO NOT ADD ANY SUBSTANCE TO THE ELECTROLYTE EXCEPT WATER.

CLEANING AND INSPECTION

The external condition of the battery and the battery cables should be checked periodically. The top of the battery should be kept clean and the battery hold-down bolts should be kept properly tightened. For best results when cleaning battery, wash first with a dilute solution of ammonia or soda to neutralize any acid present, then flush off with clean water. Care must be used to keep vent plugs tight so that the neutralizing solution does not enter the cells. The hold-down bolts should be kept tight enough to prevent the battery from shaking around in its holder, but they should not be tightened excessively as to place a strain on the battery case.

To insure good contact, the battery cable clamps should be tight on the battery posts. If the posts or cable clamps are corroded, the cables should be disconnected and the posts and clamps cleaned separately with a soda solution and a wire brush. Install clamps on battery posts and tighten firmly, then coat posts and clamps with petroleum jelly to help retard corrosion.

ON VEHICLE TESTS

Three battery checks are described below to determine condition of battery:

1. Hydrometer test.
2. Capacity test.
3. Three minute test.

If a battery failure is encountered the cause may be outside the battery itself. Do not be satisfied to merely recharge or replace battery. Find cause of failure and prevent recurrence of trouble.

NOTE: In some cases, it may be necessary to remove batteries from vehicle to obtain the necessary working space for the following checks.

HYDROMETER TEST

The hydrometer test is merely a means of determining the state of charge of the battery. This test will not necessarily indicate whether the battery is able to perform its normal functions.

1. Measure specific gravity of electrolyte in each battery cell. The hydrometer tube must be held vertically. Do not draw too much electrolyte into the hydrometer. The float must be freely suspended in the electrolyte and the reading taken at eye level. If water has been recently added to the cells, or battery fast charged, the hydrometer reading will be false.

2. Correct hydrometer reading for temperature. When electrolyte temperature is above 80 degrees F., add 4 points (.004) to reading for each 10 degrees above 80. If electrolyte temperature is below 80 degrees F., subtract 4 points for each 10 degrees below 80.

3. a. If the specific gravity readings are 1.215-1.270 at 80 degrees F., and variation between cells is less than 25 gravity points (.025), the battery presumably is at least 3/4 charged and in good condition for further use or testing of engine electrical circuits.

b. If the specific gravity readings are below 1.215 and the variation between cells is less than 25 gravity points, the battery presumably is in sound condition, but its state of charge is too low for further use or testing electrical circuits.

c. If the specific gravity readings show a variation between cells of more than 25 gravity points, an unsatisfactory battery condition is indicated which may be caused by shorted cells, acid loss, or a worn out battery.

To determine whether a battery is a good battery, regardless of its state of charge, proceed with the "Capacity Test" below:

CAPACITY TEST

This test is one means of determining whether a battery is functioning efficiently to the degree where it can be relied upon to perform all of its duties properly in the vehicle.

A battery that will maintain 9.0 volts or better during a capacity test should be considered a good battery. To make this test, use equipment that will take a heavy electrical load from the battery such as a carbon pile or other suitable means. If test equipment is not available for loading battery, the starter may be used as a load.

1. Connect positive voltmeter and ammeter

leads to battery positive post and negative voltmeter and ammeter leads to battery negative post (fig. 3). NOTE: Ammeter cable clips must contact battery posts; voltmeter cable clips must contact battery post or cable clamp, not the ammeter cable clips.

2. Apply a load to the battery of three times the ampere-hour rating of the battery for 15 seconds. Refer to "Specifications" at end of this section for ampere-hour ratings.

3. With ammeter reading specified load, read voltage which should not be less than 9.0 volts.

a. If voltmeter shows 9.0 volts or more, battery has good output capacity and will readily accept a normal charge.

(1) If specific gravity is 1.215 or more, no service is required.

(2) If specific gravity is below 1.215, check charging circuit to determine the cause and correct as required. The battery should be slow-charged for city driving. With highway driving and a good charging system, the battery should charge satisfactorily.

b. If voltmeter shows a reading of less than 9.0 volts, proceed with the "Three-Minute Test" described below:

THREE-MINUTE TEST

In cases where voltage of less than 9.0 volts is obtained in the "Capacity Test" described above, an accurate test using a voltmeter and a fast charger will quickly establish whether a battery is good or bad, even when a battery is in a discharged condition.

This procedure determines the condition of charged or discharged batteries by following the principles that:

a. A charged battery may be tested by taking current out of it.

b. A discharged battery may be tested by passing current through it.

NOTE: This test should not be used if battery temperature is below 60 degrees F.

If battery temperature is above 60 degrees F., add battery water, if necessary, and proceed with three-minute test.

CAUTION: Do not make this test, which is recommended for discharged batteries, if voltage obtained in "Capacity Test" is 9.0 volts. A charged battery will not accept 40 amperes without an excessively high voltage.

Test Procedure

If voltage obtained in "Capacity Test" was less than 9.0 volts, fast charge battery at 40 amperes for 3 minutes. Then, with fast charger still operating, test individual cell voltage of battery.

NOTE: On some batteries the cell connectors are not exposed, therefore, it may be necessary to pierce the cover to contact connector straps to obtain individual cell voltages.

a. If cell voltages are uneven by more than 0.1 volt, replace battery.

b. If all voltages are even within 0.1 volt, test total battery voltage with charger still operating on fast charge.

NOTE: If total voltage is over 15.5 volts, battery is unsatisfactory and is probably sulfated. Battery may be serviceable after a continued slow charge process as outlined under "Charging" in this section. After charging, perform "Capacity Test" as outlined above. If reading is above 9.0 volts, place back in service. If below, replace battery.

CHARGING

Batteries removed from the vehicle for charging should be charged continuously at a low rate until fully charged. Batteries may be safely slow-charged at a rate in amperes equal to 7% of the battery's ampere-hour capacity. (Refer to "Specifications" at end of this section for ampere-hour rating of batteries used.) This is called the "normal" charge rate. The battery is fully charged when specific gravity readings taken at hourly intervals show no increase during three consecutive readings.

A very low rate -- not more than one-half the normal charging rate -- should be used for charging a sulfated battery. In the case of badly sulfated batteries, as much as 100 hours of charging time may be required before the battery becomes fully charged. Badly sulfated batteries may require a continuous slow charge for 48 hours or more before a rise in gravity reading occurs. If the specific gravity reading of any cell fails to reach 1.250 (corrected to 80°F.) or if there is a variation of more than 25 gravity points between cells after thorough slow charging, replace the battery.

Although the slow-charge method is recommended for charging all batteries, discharged batteries in otherwise good condition (refer to "Battery Capacity Test") may be given a boost with a quick charger if time does not permit complete slow charging. When using a quick charger, it must be remembered that the battery is only receiving a partial charge and that the battery electrolyte temperature must not be allowed to exceed 130°F. If the battery heats up excessively, quick charging must be discontinued.

BATTERY CABLES

Check cable leads and connections to determine if they are in good condition. Excessive re-

BATTERIES

sistance, generally caused by poor connections, produces abnormal voltage drop which may lower voltage at starting motor to such a low value that normal operation of starting motor will not be obtained. Abnormal voltage drop can be detected with a low reading voltmeter as follows:

NOTE: To prevent engine from starting, place "ENGINE CONTROL" switch in engine compartment in "OFF" position.

1. Check voltage drop between grounded (negative) battery terminal and vehicle frame. Place one prod of voltmeter on battery terminal and other on vehicle frame. With starting motor cranking engine at normal room temperature (70°F.), voltage reading should be less than 0.3 volts. If more than this, there is excessive resistance in this circuit.

2. Check voltage drop between ungrounded (positive) battery terminal and starting motor terminal stud while motor is operated. If reading is more than one (1.0) volt, there is excessive resistance in circuit. NOTE: If necessary to extend wire from meter for this test, use No. 16 or larger wire.

3. Check voltage drop between starting motor housing and vehicle frame. This must be less than 0.1 volt.

SPECIFICATIONS

Make	Delco-Remy
Model	8DR205
Quantity	2, Connected Parallel
Approx. Weight Filled	154 lbs.
Voltage	12
Plates per Cell	27
Amp. Hr. Capacity @ 20 Hr. Rate	205

Starting System

GENERAL

The starting system includes batteries, starter, starter solenoid, starter relay, starter switches, circuit breakers, and interconnecting wiring and cables. Starting system control circuits are shown on "Engine Control and Generator Wiring Diagram." Refer to "Relays" in "WIRING AND MISCELLANEOUS ELECTRICAL" section for information on all relays.

CONTROL SYSTEM OPERATION

Starter control system is operative when "ENGINE" switch on driver's control panel is placed in "RUN" position. Before starter motor can be energized with starter switch, the rear start and engine control switches (fig. 1) on engine compartment control panel must be in "NORMAL" position.

When starter switch is closed, circuit is completed through starter magnetic switch, energizing starter solenoid coil. With solenoid operating coil energized, circuit is completed direct from battery to starter.

On coaches equipped with automatic engine shut-off system, circuit from "ENGINE" or "ENGINE CONTROL" switch to engine stop solenoid valve is routed through the normally closed contacts of the engine stop time delay relay. If engine fails to start within 20 seconds after circuit is energized, the time delay relay contacts will open; "ENGINE" or "ENGINE CONTROL" switch must then be momentarily returned to "OFF" position to permit the time-delay relay to reset itself and close the contacts.

CAUTION: When performing maintenance in engine compartment, place rear start or engine control switch in "OFF" position to prevent someone from starting engine with starter switch on driver's control panel.

When starting engine from rear controls, make sure transmission is in neutral position and parking brakes are applied.

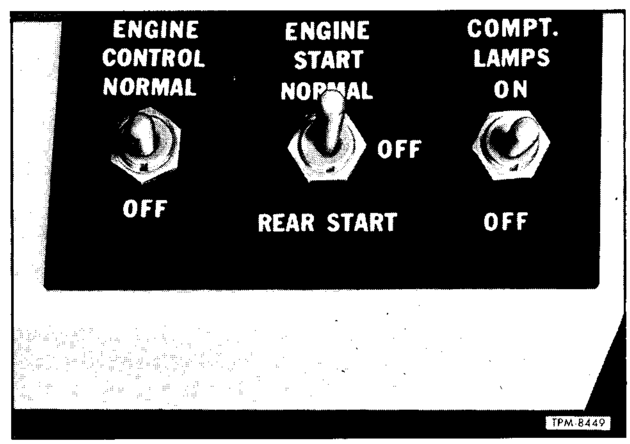


Figure 1—Engine Rear Control Panel

STARTER

DESCRIPTION

Starter (fig. 2) is a heavy duty unit, solenoid operated through an enclosed shift lever. Starter is equipped with a heavy duty sprag type overrunning clutch. A removable plug is provided in shift lever housing to permit adjustment of pinion clearance.

Armature shaft is supported in bronze bushings at three points -- in commutator end frame, in shift lever housing, and in nose housing. Positive lubrication is provided at each bushing by an oil saturated wick that projects through the bushing and contacts the armature shaft. A waste-filled oil reservoir for each wick provides a large oil supply.

O-ring seals are used between commutator end frame and field frame, and between shift lever housing and field frame. A spring-loaded lip type oil seal together with an O-ring seal in shift lever housing and a boot over the solenoid plunger prevent entry of transmission oil into the armature, field coils, and solenoid case.

Two brushes are carried in each of four holders mounted on plates which are attached to, but insulated from, the commutator end frame. As shown on wiring diagram (fig. 3), two sets of brushes connect to the ground terminal stud on commutator end frame; these connections are made through the brush holder mounting plate. The other two sets of brushes, which are insulated from the mounting plate, connect to the field coil leads.

STARTER DRIVE OPERATION

When starter circuit is energized, shift lever operated by solenoid slides the pinion into mesh with flywheel ring gear teeth. The rotary motion between pinion and ring gear, provided by the

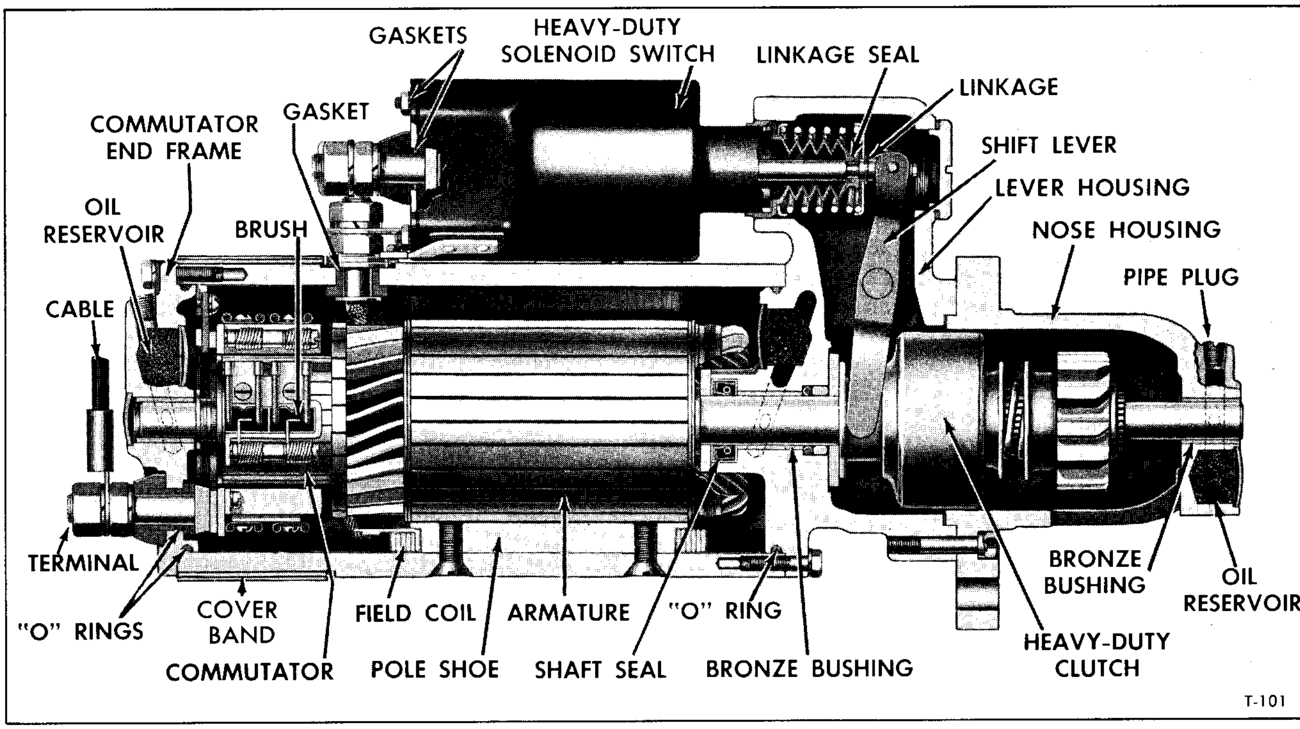


Figure 2—Starter And Solenoid Assembly

spiral splines on clutch shaft, normally relieves tooth abutment on the first attempt. A protective sleeve located on spiral spline acts as a stop for the pinion when extreme tooth abutment occurs. This limits the clutch travel, preventing the switch contacts in solenoid from closing. Therefore, armature cannot rotate before pinion is engaged properly, preventing damage to pinion and ring gear. A second attempt to engage rotates pinion enough to assure proper engagement.

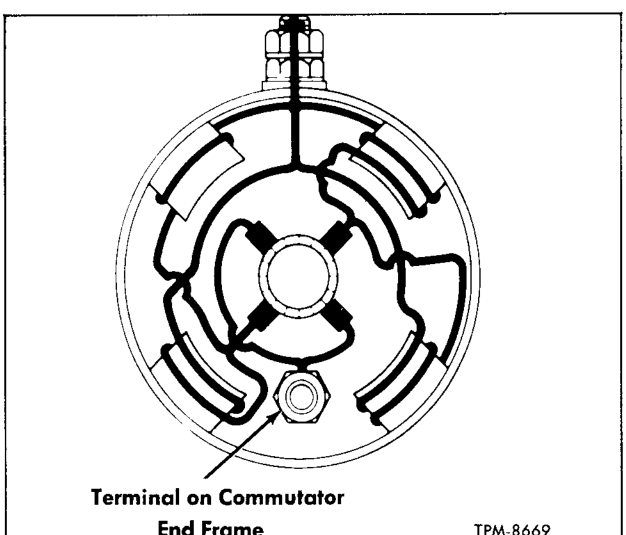


Figure 3—Starter Internal Wiring Diagram

MAINTENANCE

Other than periodic lubrication as directed in LUBRICATION (SEC. 13) and keeping cable connections clean and tight, the starter should require no periodic maintenance. The brushes can be inspected and replaced without disassembling the starting motor; however, it must be removed from the engine. Starter is accessible through transmission compartment door.

BRUSH REMOVAL

1. Remove starting motor from engine.
2. Loosen two screws holding cover band on commutator end of field frame, then remove cover band.
3. Remove screws and washers attaching brush leads and field coil leads to brush holders.
4. Using a screwdriver as shown in figure 4, bend brush holder spring back and remove brush from holder.

BRUSH INSPECTION

1. When brushes are worn down to less than one-half their original length, they must be replaced (original length is 3/4").
2. Be sure leads are secure in brushes and that clips are properly soldered to leads.

BRUSH INSTALLATION

1. Using screwdriver to bend brush holder spring as shown in figure 4, and with groove in

brush aligned with ridge in holder, insert brushes in holders.

2. Position brush leads and field coil leads to brush holders and attach with one screw and washer in each brush. Tighten screws firmly.

3. Position cover band over commutator end of field frame, and tighten cover band screws firmly.

4. Install starting motor on engine.

STARTER FREE SPEED CHECK

Before disassembling starter, the following check of starter operation can be made to determine conditions which may require special attention during overhaul.

To make this check, connect an ammeter in series with the positive (+) terminal of a 12-volt battery and the "BAT" terminal of the starter solenoid (fig. 5). For the return circuit, connect a lead from the starter frame to the battery negative (-) terminal. Connect a voltmeter from solenoid "BAT" terminal to ground on starter frame.

Use a tachometer at end of armature shaft (fig. 5) to determine armature rpm. Energize the solenoid by connecting a jumper lead from the solenoid "BAT" terminal to the solenoid switch terminal. Observe the armature rpm, voltage, and current draw. Failure of starter to operate according to values listed in "Specifications" at end of this section may be due to tight or dry bearings, or to high resistance connections.

STARTER DISASSEMBLY

(Refer to Figure 2)

1. Using a prick punch or small chisel, mark relative positions of commutator end frame and shift lever housing to field frame, and position of nose housing to shift lever housing so they can be reassembled in same positions.

2. Remove nut and lock washer attaching solenoid "MOTOR" terminal connector strap to terminal stud on field frame. Also disconnect solenoid ground lead from terminal stud on commutator end frame.

3. Remove plug and gasket from shift lever housing. Remove nut from end of solenoid plunger rod, then remove four capscrews and lock washers attaching solenoid assembly to field frame.

4. Remove six socket-head screws attaching nose housing to shift lever housing. Remove nose housing from lever housing and armature shaft.

5. Remove cover band assembly from commutator and field frame assembly. Disconnect field coil leads from brush holders.

6. Remove bolts and lock washers attaching commutator end frame to field frame. Remove commutator end frame assembly from field frame

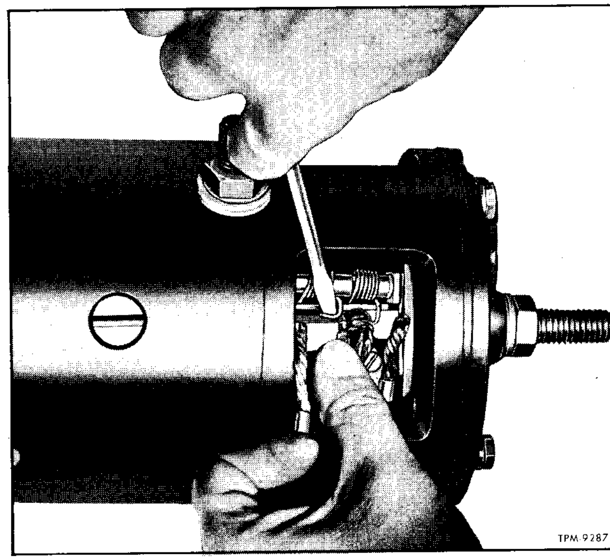


Figure 4—Removing Or Installing Brushes

and armature shaft. Remove thrust washer from armature shaft.

7. Remove bolts and lock washers attaching shift lever housing to field frame. Separate field frame from shift lever housing and remove field frame from armature.

8. Withdraw armature from shift lever housing, removing drive clutch assembly from armature shaft as armature is removed. Remove brake washer from armature shaft, and remove collar and O-ring from counterbore in shift lever housing.

9. It is not necessary to further disassemble starter unless parts require replacement as directed later under "Inspection, Tests, and Repair."

INSPECTION, TESTS, AND REPAIR

(Refer to Figure 2)

The overrunning clutch assembly, armature, and field frame and coil assembly should not be

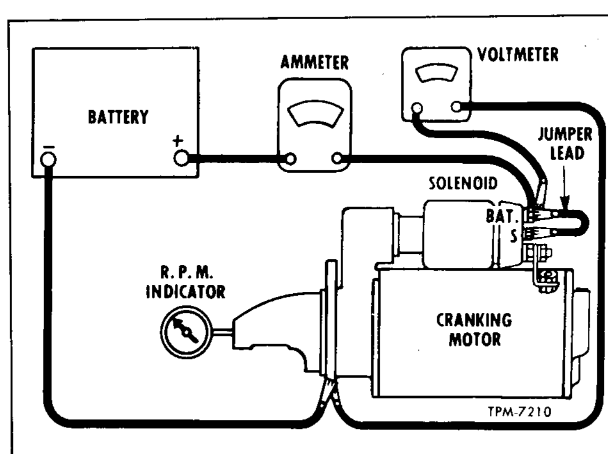


Figure 5—Test Hook-up For Checking Starter Free Speed

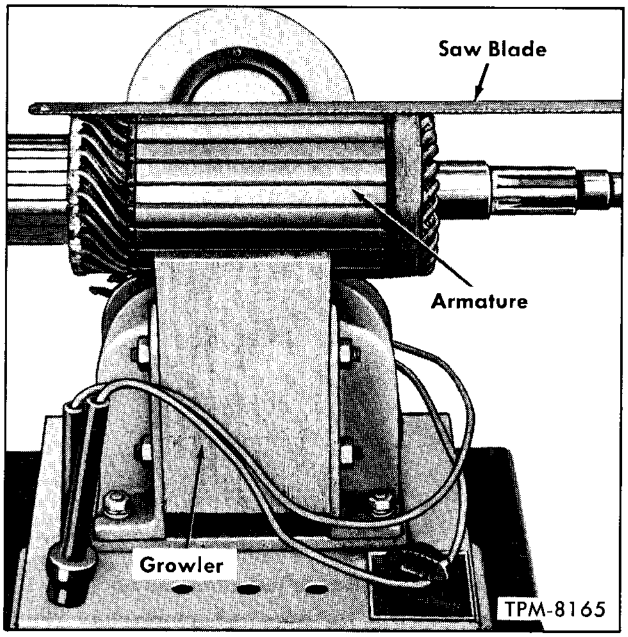


Figure 6—Checking Armature For Short Circuits

cleaned in a degreasing tank or with grease dissolving solvents, since these would dissolve the lubricant in the clutch mechanism and damage the insulation in the armature and field coils. All parts except the clutch should be cleaned with oleum spirits and a brush. The clutch should be wiped with a clean cloth. Commutator can be cleaned with No. 00 sandpaper. NEVER USE EMERY CLOTH TO CLEAN COMMUTATOR.

ARMATURE

If the armature commutator is worn, dirty, out-of-round, or has high insulation, the armature should be placed in a lathe and the commutator turned down. Do not cut deeper than necessary to remove rough spots or out-of-round condition. DO NOT UNDERCUT THE INSULATION BETWEEN THE COMMUTATOR SEGMENTS AFTER TURNING DOWN THE COMMUTATOR AS HAS BEEN THE PRACTICE IN THE PAST.

The armature should be checked for open circuit, short circuit, and grounds as follows:

Open Circuit Test

Open circuits are usually caused by excessively long cranking periods. The most likely place for an open circuit to occur is at the commutator riser bars. Inspect the points where the conductors are joined to the commutator bars for loose connections. Poor connections cause arcing and burning of commutator bars. If bars are not too badly burned, repairs can sometimes be made by resoldering the leads in the riser bars, using rosin flux solder. After soldering, turn down commutator.

Short Circuit Test

Short circuits in the armature are located by the use of a growler. When armature is rotated in the growler with a steel strip such as a hacksaw blade held above it, the blade will vibrate above the area of the armature core in which the short circuit is located (fig. 6). The possibility of shorts between the bars is eliminated because of insulation type and high copper content brushes.

Ground Test

Grounds in the armature can be detected with a 110-volt test lamp and test points. If the lamp lights with one test point on commutator and the other on the core or shaft, the armature is grounded. Grounds occur as a result of insulation failure, which is often brought about by overheating due to excessively long cranking periods, or by accumulation of brush dust between the commutator bars and the steel commutator ring.

FIELD COILS

Internal wiring circuits are shown in figure 3. Connect one test lamp lead to the field frame and the other to the terminal stud on the field frame. If lamp lights, at least one of the field coils is grounded and it must be repaired or replaced.

Connect one test lamp lead to the terminal stud on field frame and the other, in turn, to each of the field coil leads which connect to the brush holders; lamp should light. If lamp fails to light in either case, the field coils are open.

Field Coil Replacement

Field coils can be removed from the field frame by using a pole shoe screwdriver. A pole shoe spreader should also be used to prevent distortion of the field frame. Careful installation of the field coils is necessary to prevent shorting or grounding the field coils as the pole shoes are tightened into place. Each pole shoe has a long lip on one side and short lip on the other; they should be installed with the long lip pointing in the direction of armature rotation so it becomes the trailing (not leading) edge of the pole shoe.

COMMUTATOR END FRAME

Remove all brushes. Place one test lamp lead on end frame, and the other, in turn, on each of the brush holders and on terminal stud. If lamp lights it is an indication of defective brush holder insulation or terminal insulators. Replace defective insulators under brush holder mounting plates or at terminal stud.

Check brush spring tension. If not within limits listed in "Specifications" at end of this section, replace with new springs. Examine brush holders and hinge pins for bent or damaged condition. Any condition which might prohibit free brush action must be corrected.

Examine bushing in end frame for excessive wear or out-of-round condition. Original diameter of bushing is listed in "Specifications" at end of this section. Replace bushing, if necessary, as directed following.

Bushing Replacement

1. Remove expansion plug from armature shaft bore.
2. Remove expansion plug from oil reservoir and remove pipe plug from oil wick passage. Remove packing and oil wick from reservoir.
3. Press old bushing from endframe and press new bushing into place.
4. Using a drill same size as oil wick passage, run drill through passage to cut through edge of bushing. Remove burrs from bushing caused by drilling operation.
5. Install new oil wick and fill oil reservoir with fine wool packing material. Saturate reservoir packing and oil wick with engine oil, then install new expansion plug with gasket in oil reservoir opening.
6. Install new expansion plug with gasket in armature shaft bore in end frame.

SHIFT LEVER HOUSING

Inspect oil seal and bushing in shift lever housing for evidence of damage or excessive wear. Original diameter of bushing is listed in "Specifications" at end of this section. Replace bushing, if necessary, as directed in "Bushing Replacement" under "Commutator End Frame," omitting steps 1 and 6. When installing new oil seal, lip must point inward.

If shift lever appears excessively loose on lever shaft, worn parts can be replaced by removing retaining ring from exposed small end of lever shaft, then driving shaft out of housing. When installing lever and shaft, use new O-rings in grooves in shaft.

NOSE HOUSING

Inspect bushing in nose housing for wear, referring to "Specifications" for original bushing diameter. Replace bushing, if necessary, as directed in "Bushing Replacement" under "Commutator End Frame," omitting steps 1 and 6.

OVERRUNNING CLUTCH ASSEMBLY

Drive pinion must rotate freely in overrunning direction and must not slip in cranking direction. The overrunning clutch can be serviced as follows, referring to figure 7.

Disassembly

1. Using suitable tools, remove the pinion stop cup and split washers from sleeve.

NOTE: In removing the pinion stop cup, cup will be damaged. Use new cup at assembly.

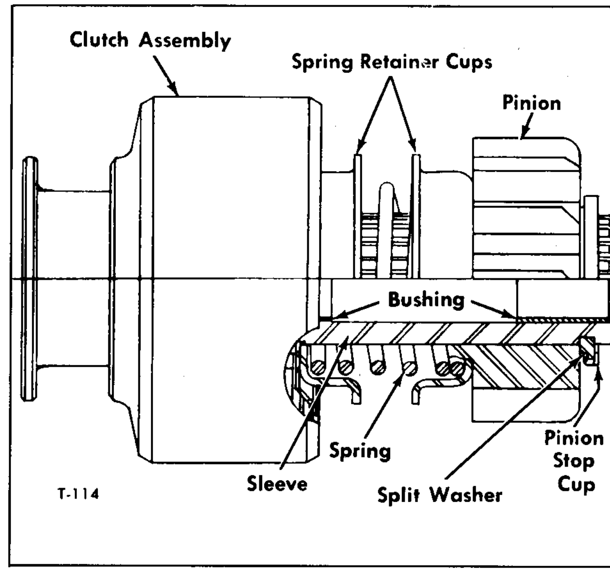


Figure 7—Drive Clutch Assembly

2. Remove pinion, spring retainer outer cup, spring, and spring retainer inner cup.

Inspection and Repair

1. Inspect spring and spring retainer cups. If not in good usable condition, replace with new parts.
2. Inspect pinion. If teeth are chipped or cracked, replace pinion.
3. Inspect sleeve bushings. If bushings do not meet specifications listed at end of this section, press old bushings out of sleeve and press new bushings into place. Ream bushings to "Specifications" listed at end of this section.

Assembly

1. Install spring retainer inner cup, spring, and spring retainer outer cup on sleeve.
2. Install pinion and pinion stop cup on clutch sleeve.
3. Install split-type washers in groove at end of clutch sleeve.
4. Position clutch sleeve assembly in a vise; then with pinion seated firmly against the pinion stop cup, and using suitable tools, bend pinion stop cup lip over split washers, locking pinion stop and split washers together.

STARTER ASSEMBLY

(Refer to Figure 2)

1. Lubricate splines of armature shaft with engine oil, then insert drive end of armature shaft through shift lever housing until shaft just extends through housing. Place O-ring and collar over armature shaft and position in counterbore in housing. Place brake washer over end of shaft.
2. Position drive clutch assembly in lever

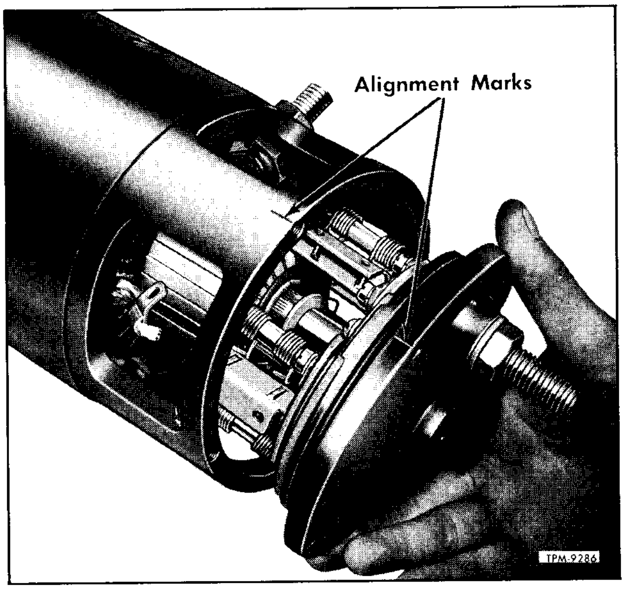


Figure 8—Installing Commutator End Frame

housing with lugs on lever yoke engaging groove in drive clutch shift collar, then push armature shaft through housing and drive clutch.

3. Place gasket in counterbore in shift lever housing, then install nose housing over armature shaft and position at lever housing, with marks made prior to disassembly aligned. Attach nose housing to lever housing with six socket head screws; tighten screws to 13-17 foot-pounds torque.

4. Install new O-ring in groove in field frame side of shift lever housing. Install field frame over armature and position against shift lever housing, with marks made prior to disassembly aligned. Attach lever housing to field frame with five cap screws and lock washers. Tighten cap screws firmly.

5. Position solenoid with plunger assembly on field frame, inserting plunger rod end of solenoid into shift lever housing. Through opening in opposite side of lever housing, make sure plunger rod passes through plunger rod guide in shift lever. Thread adjusting nut a few turns onto plunger rod. Attach solenoid to field frame with four cap screws and lock washers. Install connector strap on solenoid "MOTOR" terminal and field frame terminal stud.

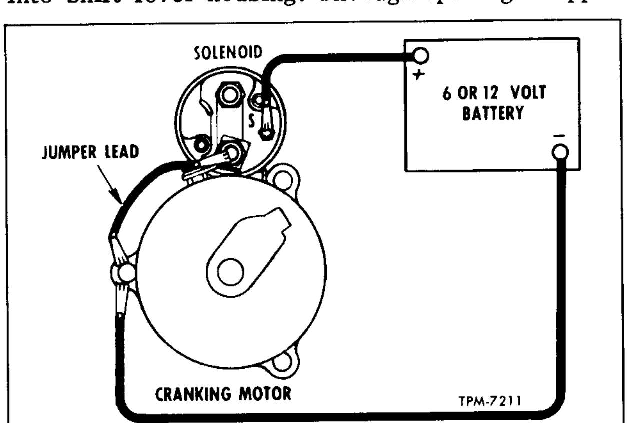


Figure 9—Test Hook-up For Checking Pinion Clearance

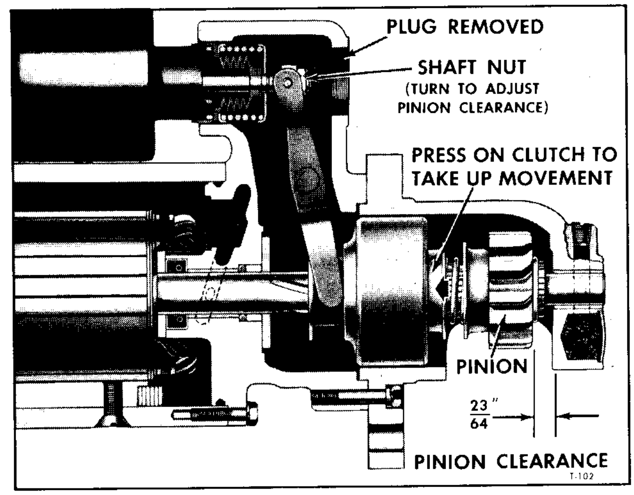


Figure 10—Pinion Clearance Check And Adjustment

6. Place thrust washer over commutator end of armature shaft. Place new O-ring in groove around commutator end frame. With marks made prior to disassembly aligned, install end frame to field frame as shown in figure 8. Attach end frame to field frame with four cap screws and lock washers; tighten firmly. Through openings in field frame, install brushes and connect field coil leads to brush holders as previously directed in "Brush Installation" under "Maintenance."

7. Install cover band over commutator end of field frame and tighten two screws firmly. Connect solenoid ground lead to terminal stud on cummutator end frame.

NOTE: In order to prevent early starter failure by the entrance of water, oil, or cleaning spray, care should be taken to prevent crimping cover band during installation.

8. Adjust pinion clearance as directed below.

PINION CLEARANCE ADJUSTMENT

1. To check the pinion clearance, connect a 6-volt battery from solenoid switch terminal to starter frame (fig. 9). If solenoid does not operate, use a 12-volt battery. To prevent starter from motoring, connect a heavy jumper from solenoid "MOTOR" terminal to starter frame (fig. 9).

2. With solenoid energized and drive clutch shifted toward the nose housing, push the pinion back toward armature to take up slack, then check clearance between the pinion and nose housing (fig.

10). Adjust nut on solenoid plunger rod as necessary to obtain the proper clearance of 23/64 inch. After correct adjustment is obtained, install access plug and gasket in shift lever housing.

STARTER SOLENOID

Starter solenoid is used to shift the starter drive pinion into engagement with flywheel teeth and to complete the circuit from battery to starter.

Solenoid has two windings, the pull-in winding and the hold-in winding. When starter switch is closed, both windings are energized, producing a magnetic field which pulls the plunger in. Inward movement of plunger shifts starter pinion into engagement with flywheel ring gear teeth, and closes the main contacts in the solenoid switch to complete the circuit from battery to starter.

The pull-in winding draws comparatively heavy current for a short interval. This is required to shift the pinion into engagement. The hold-in winding also aids the pull-in winding. As soon as plunger closes the main switch contacts, pull-in winding is de-energized and only the hold-in winding draws current for the balance of the starting cycle.

SOLENOID MAINTENANCE

Solenoid requires no periodic maintenance other than keeping the terminals clean and tight. Always check action of solenoid if it has been removed. If unit fails to function, first check wiring before condemning the solenoid. Solenoid windings can be checked for current draw, open circuit, or shorts. Refer to "Specifications" at end of this section for current values. Solenoid coil, terminals, and switch plunger can be replaced if burned or otherwise damaged. Whenever solenoid is replaced, pinion clearance must be checked and adjusted, if necessary, as previously directed in starter assembly procedures.

SPECIFICATIONS

Make	Delco-Remy
Starter Model	1114100
Rotation (Viewing Drive End)	Counterclockwise
Minimum Brush Spring Tension	80 oz.
No-Load Test	
Volts	11
Maximum Amps	170
Minimum Rpm	6300
Lock Test	
Volts	1.5
Maximum Amps	700
Minimum Torque (Ft. Lbs.)	15
Bushing Diameters (I.D.)	
Commutator End Frame	0.540"-0.544"
Shift Lever Housing	0.810"-0.813"
Nose Housing	0.625"-0.627"
Drive Clutch Sleeve*	0.6245"-0.6260"
Starter Solenoid Model	1119895
Current Consumption @ 80° F.	
Both Windings	
Amperes	65.3-73.3
Volts	10
Hold-in Winding	
Amperes	12.7-14.3
Volts	10

*Burnish after installing

STARTER AND BATTERY CABLE CONNECTIONS MUST BE KEPT CLEAN AND TIGHT FOR SATISFACTORY OPERATION.

Generator

The generating system consists of an engine-driven, oil-cooled brushless generator, a transistorized voltage regulator, and a generator relay. Information concerning the transistorized voltage regulator is covered in "**REGULATOR**" section later in this group. The generator relay is covered under "Relays" in "WIRING AND MISCELLANEOUS ELECTRICAL" section.

IMPORTANT

The electrical system on these coaches is NEGATIVE GROUND. It must be emphasized that if the batteries are not connected for a NEGATIVE GROUND system, severe damage to the generator, regulator, batteries, and battery cables will result.

GENERAL

The oil-cooled generator is a self-rectifying AC generator in which all current carrying members, windings, built-in diodes, and field coils are stationary. It is a totally enclosed unit, cooled and lubricated by engine oil. The oil inlet is on the diode end frame and the oil drains back into the engine crankcase through the drive end frame and gear train cover as shown in figure 1. The generator should never be operated with the oil line disconnected.

Power output is DC with a maximum rating of 300 amperes. It will produce 150 amperes at approximately 440 engine rpm.

The generator has three terminals (fig. 2); the DC power output terminal, a field terminal, and a relay terminal. The relay terminal provides voltage only for the generator relay. Generating system wiring diagram is schematically illustrated

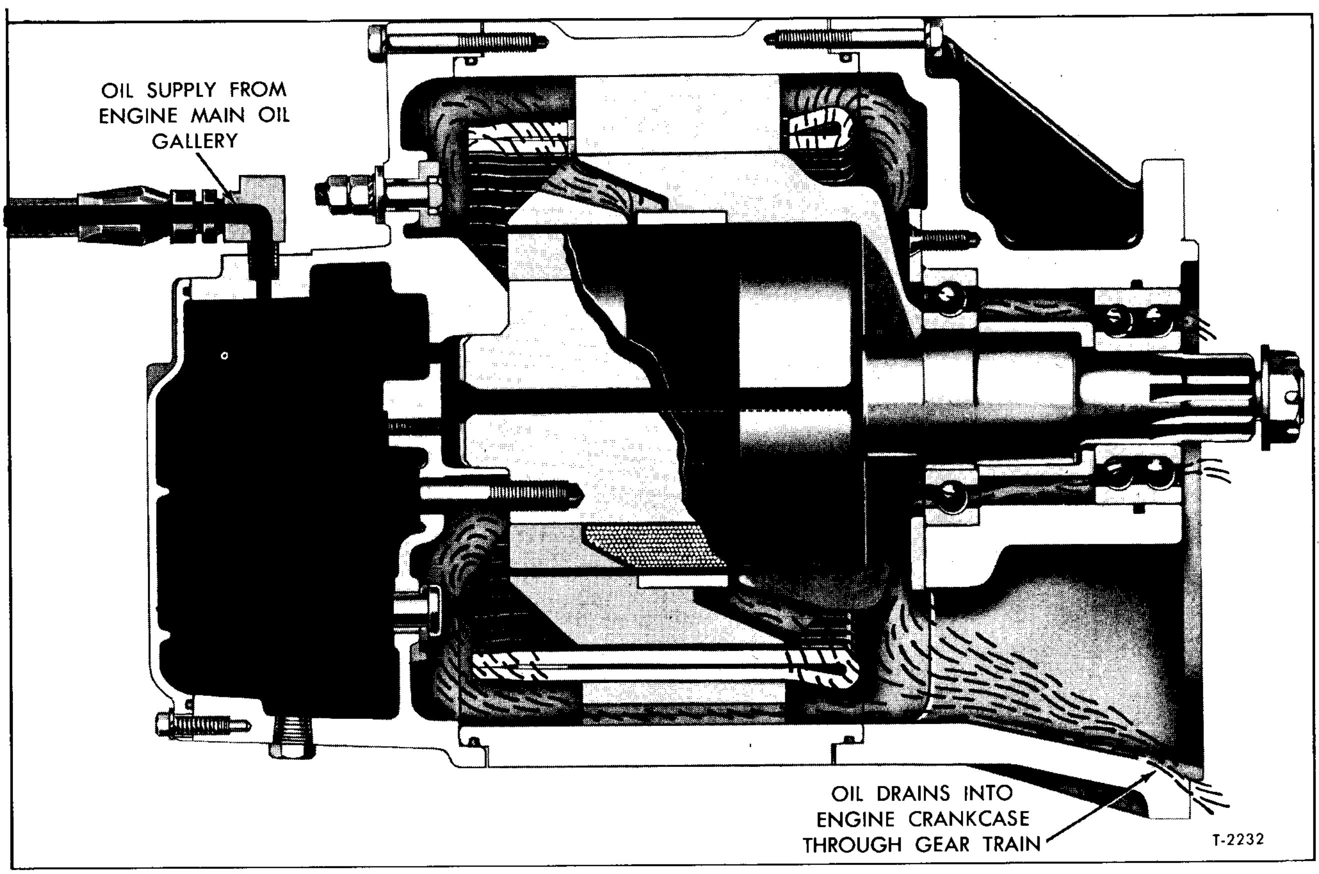


Figure 1—Oil Circulation Through Generator

GENERATOR

in figure 3. Refer to "Engine Control and Generator Wiring Diagrams" in back of this manual for complete electrical circuit diagram.

The generator has inherent current regulation so that an external current regulator is not needed. The use of silicon diodes eliminates the need for a cut-out relay, since current cannot flow in reverse direction through the diodes.

PRECAUTIONS

1. Electrical system is NEGATIVE GROUND. Connecting the batteries with positive ground will

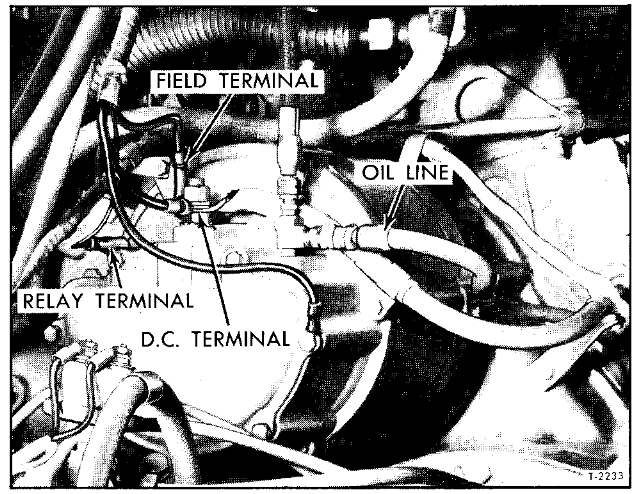


Figure 2—Oil-Cooled Generator Installed

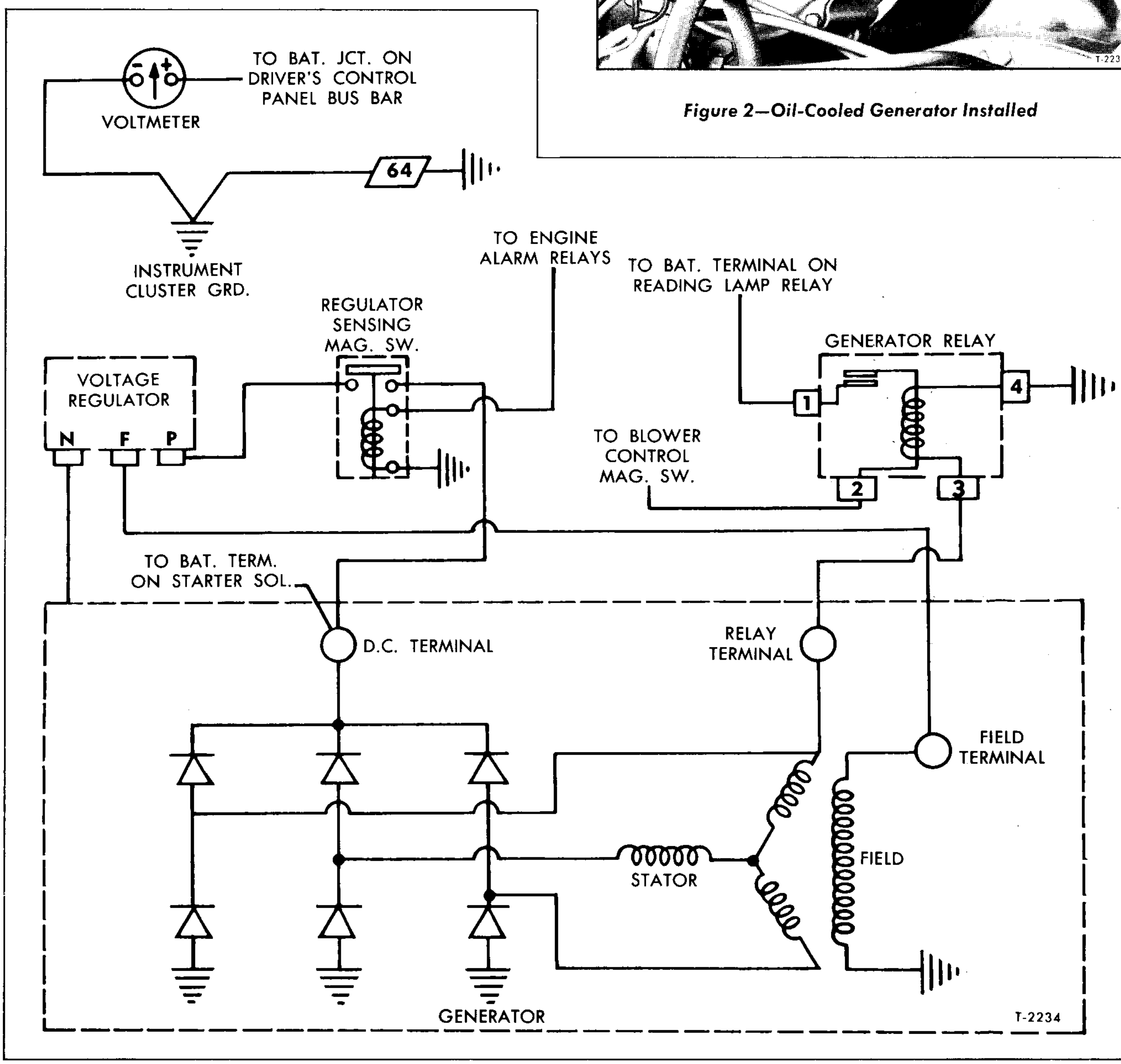


Figure 3—Generating System Schematic Wiring Diagram

result in severe damage to the generator, regulator, batteries, and battery cables.

2. The common trouble-shooting practice of momentarily grounding the generator field terminal to determine presence or absence of field power MUST BE AVOIDED. Grounding the generator field terminal will instantly overload and destroy the transistors within the regulator.

3. The generator output terminal is energized whenever the batteries are connected. If work is to be done near the generator, the batteries should be disconnected to prevent accidental grounding at the generator power output terminal.

MAINTENANCE

Because of the absence of brushes, commutator, and rubbing seals, the generator requires no periodic maintenance.

ON-VEHICLE CHECKS

Abnormal operation of the generating system is indicated by a voltmeter in the instrument panel in front of driver. Normally, the voltmeter will indicate a charge when the engine is started and generator is charging. If voltmeter fails to indicate a charge during operation, trouble in the generating system is indicated. The following quick checks will determine if the trouble is in the generator, or generator relay. If trouble is found not to be in one of these units, refer to "REGULATOR" section later in this group for further checks. Any unit which is found to be defective must be repaired or replaced. Internal checks of the generator components can be made as directed later under "Generator Repair."

PRELIMINARY CHECK

First check the entire generating system for loose connections and broken wires.

GENERATOR OUTPUT CHECK (Fig. 4)

1. Disconnect battery cable at battery.

2. Disconnect all leads from regulator and disconnect lead from generator field terminal.

CAUTION: Do not allow leads to touch ground.

3. Connect a voltmeter and ammeter in circuit (shown in figure 4) as follows:

a. Connect one ammeter lead to battery positive post and the other ammeter lead to generator "DC" terminal.

b. Connect one voltmeter lead to generator "DC" terminal and the other voltmeter lead to ground on generator frame.

4. Connect a jumper lead from generator "DC" terminal to generator "F" field terminal.

5. Connect a carbon pile load across battery as shown.

NOTE: Make sure carbon pile is turned off.

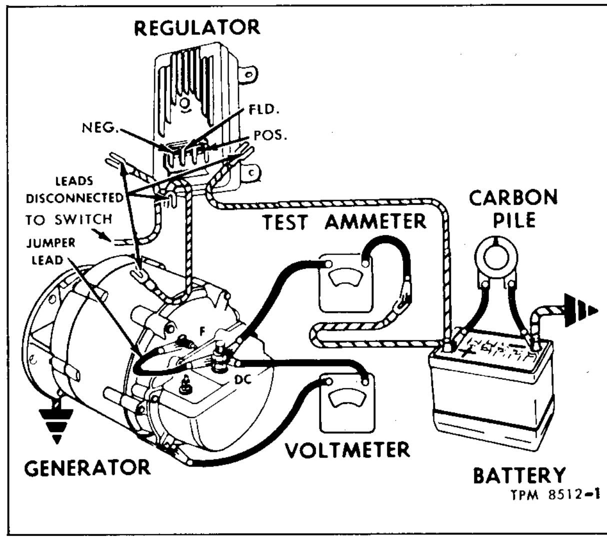


Figure 4—Checking Generator Output

6. Reconnect battery cable at battery.

7. Start engine and operate at approximately 1500 rpm (3100 generator rpm).

8. Turn on all vehicle accessories and adjust carbon pile load until a 300 ampere current draw is shown on ammeter.

9. Check voltmeter; a minimum voltage reading of 14 volts should be obtained.

10. If generator fails to perform as explained in steps 8 and 9, generator is defective. Check component parts of generator as explained under "Troubleshooting."

GENERATOR RELAY

Generator relay is powered from the relay terminal of the generator and closes when the generator is charging.

1. Connect voltmeter leads to No. 3 terminal of relay and to vehicle ground.

2. Start engine. A reading of 6 to 7 volts is normal and indicates proper feed to relay.

3. Connect voltmeter leads to No. 1 terminal of relay and to vehicle ground. Voltmeter should read battery voltage when generator is charging. No voltage indicates a defective relay.

GENERATOR REPLACEMENT

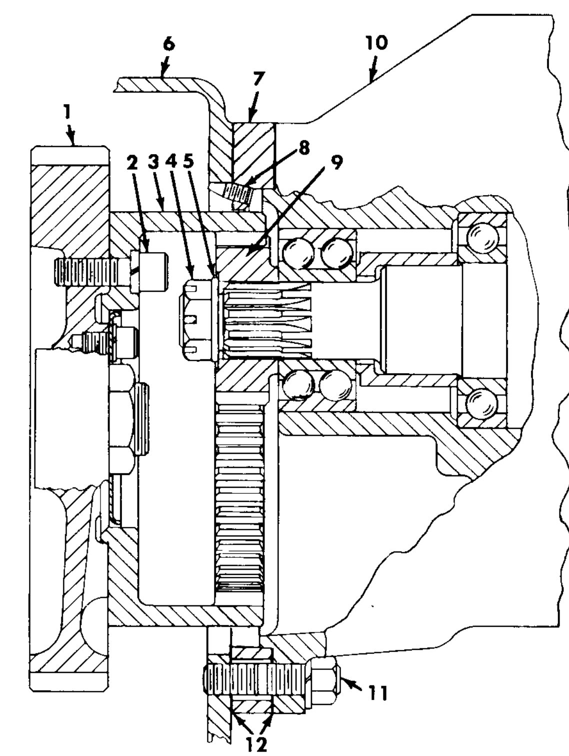
REMOVAL

Refer to figure 5.

1. Remove drain plug from bottom of diode end frame and drain oil into a container. Reinstall drain plug after draining.

2. Disconnect wires from "F" and "RELAY" terminals and disconnect battery cables from "DC" terminal on diode end frame. Tape ends of battery cables to prevent short circuit, and tag wires removed from other terminals for identification at

GENERATOR



1 Camshaft Gear
2 Socket-Head Screw
3 Drive Gear
4 Gear Retaining Nut
5 Flat Washer
6 Flywheel Housing
7 Generator and Power Steering Pump Adapter
8 Socket Head Screw
9 Driven Gear
10 Generator End Frame
11 Mounting Stud
12 Gaskets

Figure 5—Generator Drive

time of installation.

3. Disconnect flexible oil lines from tee on diode end frame. Remove clips securing flexible oil line and wiring to generator end frames. Disconnect ground wire from diode end frame cover attaching bolt.

4. Remove nuts and lock washers from six mounting studs. Pull generator straight back off mounting studs to complete removal.

5. If a new or rebuilt generator is to be installed, remove driven gear for installation on replacement unit.

INSTALLATION

Key numbers in text refer to figure 5.

1. Before installing generator, inspect drive gear (3) for worn or damaged teeth. If wear or damage is evident, drive gear must be replaced as follows:

a. Remove six socket-head set screws (2) and lock washers attaching internal-toothed drive gear (3) to camshaft gear (1). Remove gear.

b. Position new drive gear (3) on camshaft gear (1), with pilot of drive gear entering pilot bore in camshaft gear. Install six socket-head set screws (2) with lock washers and tighten firmly.

c. Clamp a dial indicator to drive gear (3) in such a manner that indicator pin will contact the generator end frame pilot bore in the generator and power steering pump adapter (7). Turn engine over with starter while observing reading on dial indicator. Runout of pilot bore with axis of shaft should not exceed 0.002" total indicator reading. If necessary, loosen four bolts attaching adapter (7) (at power steering pump) to flywheel housing and adjust tapered set screws (9) to locate adapter within limits. After the proper concentricity is obtained, tighten the four adapter to flywheel housing bolts at power steering pump.

2. Install drive gear (9) on generator rotor shaft and secure with flat washer (5) and nut (4). Tighten nut to 180 foot-pounds torque and secure with cotter pin.

3. Place gasket (12) over generator mounting studs. Position generator assembly on engine, with holes in end frame flange over mounting studs (11) and with teeth of driven gear engaging teeth in drive gear. Install lock washers and nuts on mounting studs and tighten firmly.

4. Install wiring harness to clips on generator and connect ground wire to end cover bolt as shown in figure 2.

5. Connect flexible oil lines to tee on diode end frame. Secure oil line in clip on generator drive end frame.

IMPORTANT

Foreign material may clog the oil inlet orifice in the diode end frame. When replacing or connecting oil lines, use extreme care to prevent foreign material getting into the oil lines or fitting.

6. Connect wires to "F" and "RELAY" terminals and connect battery cables to "DC" terminal. Tighten terminal nuts firmly.

7. Make sure drain plug is installed and securely tightened in diode end frame.

8. NOTE: When oil was drained from the diode end frame, this removed approximately one quart of oil from the engine oil supply. After running engine to fill the diode end frame, check engine oil level and replenish as necessary as directed in LUBRICATION (SEC. 13).

TROUBLESHOOTING

GENERAL

It is not necessary to completely disassemble the generator to make electrical checks. All electrical checks are made at the diode end of the assembly without disassembling the rotor, drive end frame, and bearing. If electrical components are not defective, but bearing replacement is necessary, this is accomplished at the drive end without disassembling the diode end of the unit as explained under "Generator Repair."

These procedures are based on the assumption that "On-Vehicle Checks" have indicated that the generator is malfunctioning and that the generator has been removed from the engine as previously directed under "Generator Replacement."

DIODE END COVER REMOVAL

1. Remove seven bolts and lock washers attaching diode end cover to diode end frame (fig. 6).
2. Remove diode end cover from diode end frame and remove O-ring from cover.
3. Disconnect all diode flexible leads, three from output terminal stud and three from diode supports (fig. 7).

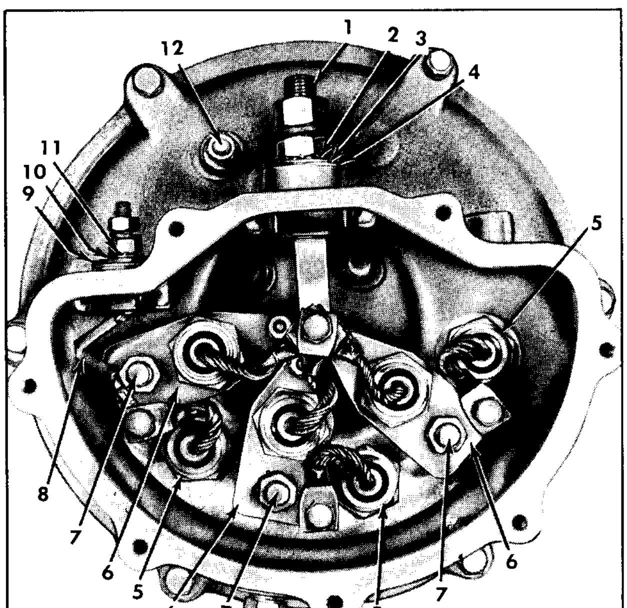


Figure 6—Diode End With Cover Removed

DIODE CHECKS

NOTE: When checking diodes for shorts and opens, use an ohmmeter with a 1-1/2 volt cell. Select a scale on which the 300 ohm value lies within the middle third of the scale.

CHECKING DIODES FOR SHORTS

If a reading of 300 ohms or less is obtained in either of the checks below, most likely the diode being tested is defective. Diode should be replaced as explained under "Generator Repair" later in this section.

Diodes Mounted in Supports

To check diodes mounted in supports, connect the positive lead of ohmmeter to each diode lead and the negative lead to each support as shown in parts A, B, and C of figure 7. If reading of 300 ohms or less is obtained, replace diode.

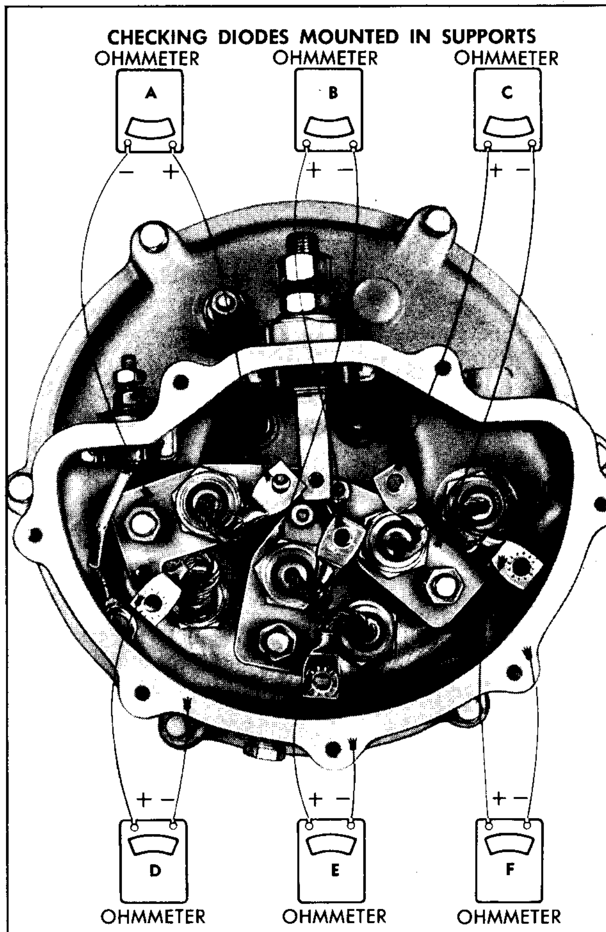


Figure 7—Checking Diodes For Shorts

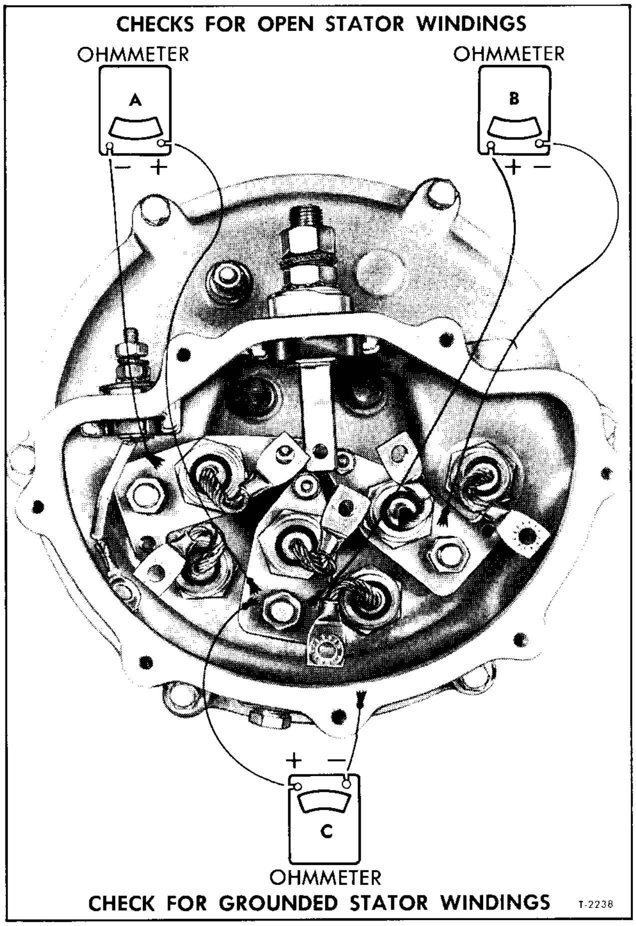


Figure 8—Checking Stator Windings

Diodes Mounted in End Frame

To check diodes mounted in endframe, connect the positive lead of ohmmeter to each diode lead and negative lead to end frame as shown in parts D, E, and F of figure 7. If a reading of 300 ohms or less is obtained, replace diode.

CHECKING DIODES FOR OPENS

To check diodes for opens, reverse leads of ohmmeter and accomplish procedures given under "Diodes Mounted in Supports" and "Diodes Mounted in End Frame." An infinite resistance reading indicates an open diode.

FIELD WINDING CHECKS

The preferred method for checking generator field windings for opens, grounds, and shorts is to check the amperage draw of the field windings:

Make check as follows:

1. Disconnect diode leads.
2. Connect an ammeter with a 12 volt battery in series with the generator field ("F") terminal and ground (on diode end frame).
3. Generator field should pass 8.1 to 8.45 amperes with 12 volts applied.
4. Amperage readings other than the above indicate an open, grounded, or shorted field winding.

STATOR WINDING CHECKS

OPENS

To check stator windings for open, connect ohmmeter leads to two pairs of diode supports as shown in parts A and B of figure 8. The ohmmeter should show a low resistance. If an infinite or high resistance is obtained in either one or both of the checks, the stator windings are open.

GROUNDS

To check stator windings for grounds, connect an ohmmeter to diode support and diode end frame as shown in part C of figure 8. The ohmmeter should show an infinite or very high resistance. If a zero or very low resistance reading is obtained, the windings are grounded. As an alternate method, the windings may be checked for grounds using a 1000 volt AC power supply unit such as Model 412 Portable Hypot Jr. or equivalent.

To use the power supply, connect one test lead from the power supply to one terminal of the stator and the other test lead to the stator frame. Leave power supply connected for five (5) seconds and observe indicator light on power supply. If light illuminates, the stator is grounded. Repeat the above test for the remaining two stator leads.

SHORTS

The stator windings are difficult to check for shorts without laboratory test equipment due to the very low resistance of the windings. However, if all other generator checks are satisfactory, yet the generator fails to perform according to specifications, shorted stator windings are indicated.

GENERATOR REPAIR

CLEANING AND INSPECTION

Whenever generator is disassembled, the following cleaning and inspection should be accomplished:

CLEANING

If sludge has accumulated on the stator, a light mineral oil should be used to clean the stator.

INSPECTION

When generator has been disassembled to a point that the stator is exposed, the stator should be checked for the following:

a. Adequate varnish.

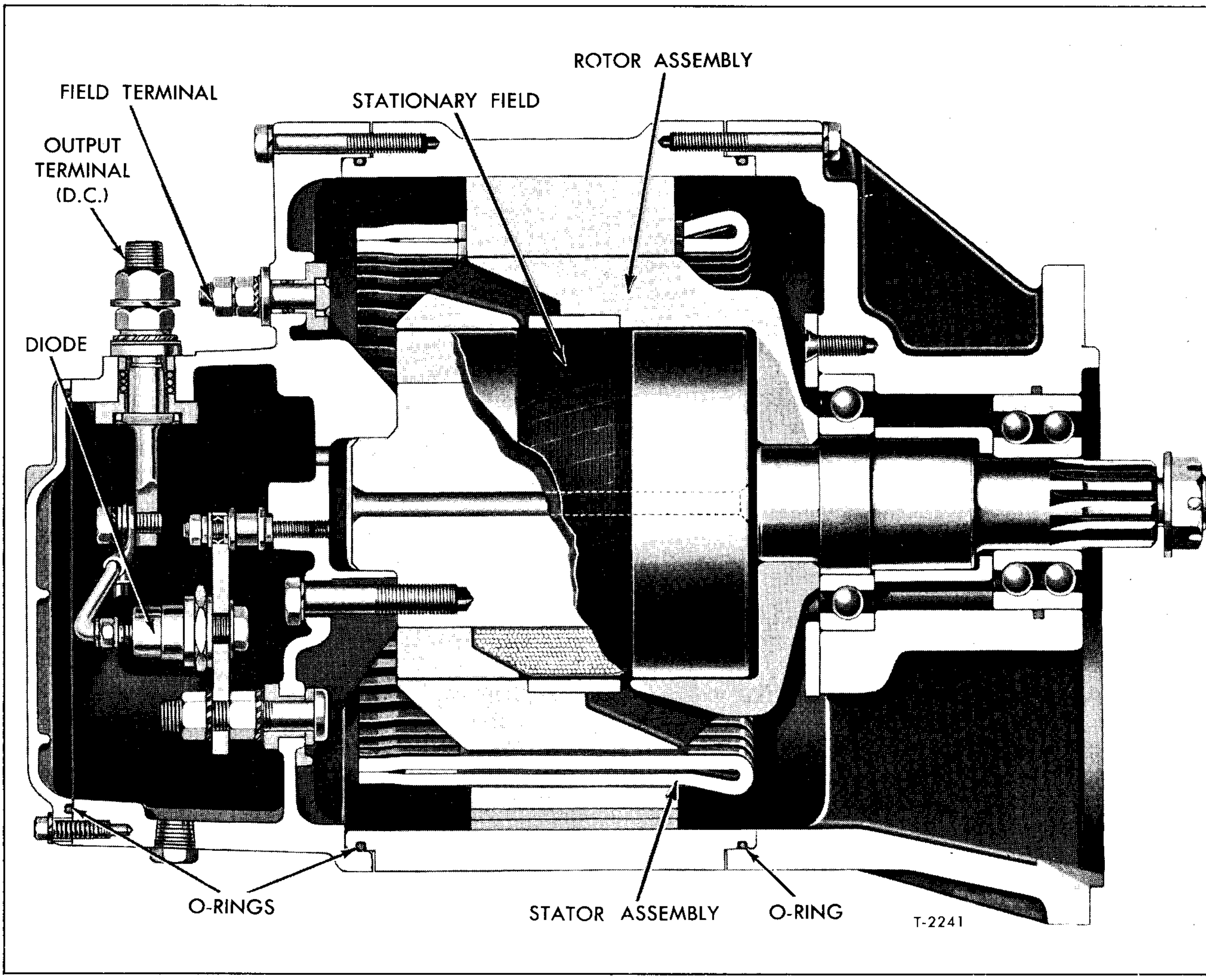


Figure 9—Oil-Cooled Generator Assembly

b. Proper spacing of conductors so that "near-shorts" do not exist.

c. Proper phase lead placement.

d. Strong conductors and cross-over welds.

REPLACEMENT OF ELECTRICAL COMPONENTS

NOTE: The replacement procedures which follow are based on the assumption that the diode end cover is still removed and diode leads disconnected as required during the preceding tests.

DIODE REPLACEMENT

IMPORTANT: When replacing a diode, make sure it is designed for a negative ground system. Diode can be identified by the symbol - stamped on diode case. The arrow must point toward the diode flexible lead.

To replace the three diodes which are mounted in supports attached to stator lead studs (fig. 6), it is necessary to remove the diode and support assembly.

Diode (In Support) Replacement

Refer to figures 6 and 9 for assembled views.

1. Remove nut w/lock washer attaching diode support to stator lead stud.
2. Remove nut, lock washer, and flat washer attaching support to small stud in end frame.
3. Remove diode and support assembly, then remove insert from small hole in support or from small stud in end frame.
4. Remove nut and flat washer from diode mounting stud, then remove diode from support.
5. Place new diode in support and install flat washer and nut on diode mounting stud. Hold diode with wrench on flats of diode while tightening nut on mounting stud to 160-180 inch-pounds torque.
6. Place diode and support assembly over

stator lead stud and small mounting stud. Place insert over small stud inside the hole in support. Install flat washer, lock washer, and nut on small stud and tighten to 22-25 inch-pounds torque. Install nut w/lock washer on stator lead stud and tighten firmly.

Diode (In End Frame) Replacement

Refer to figures 6 and 9 for assembled views.

To remove diode, use a thin 1-inch open end wrench on flats of diode case to unscrew diode from end frame. Coat threads of new diode with silicone grease, thread into end frame and tighten to 100-180 inch-pounds torque.

If no other parts are to be replaced, refer to "Diode End Cover Installation" later to complete the assembly.

FIELD REPLACEMENT

Refer to figure 9 for assembled view.

Removal

1. Remove three diode and support assemblies from end frame as previously described in this section.

2. Remove nut w/lock washer and flat washer from three stator lead studs.

3. Remove six bolts and lock washers attaching diode end frame to stator frame.

4. Separate end frame from stator frame and withdraw end frame and field assembly from rotor, at the same time pushing stator lead studs out of end frame.

5. Remove nut, lock washer, flat washer, and insulating washer securing field lead terminal stud in end frame. Push stud out of end frame.

6. Remove field terminal stud insulating bushing and O-rings from end frame. Remove insulating sleeve from field terminal stud.

7. Remove four bolts and lock washers attaching field to end frame.

8. To separate field from end frame, install four 3/8-24 x 3" bolts in place of the 3/8-24 x 2" attaching bolts removed in step 7. Thread bolts in to equal heights. Support end frame in arbor press, and using a suitable press plate to exert force on all four bolt heads, press field out of end frame.

Installation

1. Position field assembly at end frame, insert four 3/8-24 x 3" bolts through end frame, and thread into field to keep holes aligned.

2. Support end frame on arbor press bed in such a manner that the diodes will not be damaged and press field into end frame. Press in until shoulder on field core bottoms against end frame.

3. Remove the four guide bolts. Install four 3/8-24 x 2" bolts, using new lock washers, attaching field to end frame and tighten securely.

4. Place insulating sleeve in inner side of field terminal stud hole in end frame and insert terminal stud through sleeve. Place two O-rings and insulating bushing over terminal stud and push into hole in end frame. Install insulating washer, flat washer, toothed lock washer, and nut on terminal stud and tighten firmly.

5. Install each of three stator lead studs in end frame as follows: Place insulating washer over stud and insert stud through end frame. Place insulating bushing over stud and position in hole in end frame. Install flat washer and nut w/lock washer on stud and tighten firmly.

6. Install three diode and support assemblies on end frame as previously directed under "Diode Replacement."

7. Install new O-ring seal in notch around end of stator frame. Insert field into rotor and position end frame against stator frame. Attach end frame to stator frame with six bolts and lock washers. Tighten bolts firmly.

8. If no other parts require replacement, refer to "Diode End Cover Installation" later to complete the assembly.

STATOR REPLACEMENT

Refer to figure 9 for assembled view.

If tests indicated an open circuit or short in the stator, the stator and frame assembly must be replaced.

Removal

1. Remove diode end frame and field assembly as previously directed in steps 1 through 4 under "Removal" in "Field Replacement" procedure.

2. Remove six bolts and lock washers attaching stator frame to drive end frame.

3. Separate stator frame from drive end frame and remove from end frame and rotor.

Installation

1. Position new O-ring seal in notch around drive end of stator frame.

2. Position stator and frame assembly over rotor against drive end frame. Attach stator frame to drive end frame with six bolts and lock washers. Tighten bolts firmly.

3. Install diode end frame and field assembly as directed in steps 5, 6, and 7 under "Installation" in "Field Replacement" procedure.

4. Install diode end cover as directed later.

DIODE END COVER INSTALLATION

Refer to figures 6 and 9 for assembled views.

1. Make sure all diodes are properly installed and securely tightened. Leads from diodes threaded into end frame must be securely attached to diode supports. Relay terminal lead must also be

attached to left diode support as shown in figure 6.

2. Connect leads from three diodes mounted in supports to output terminal stud as shown in figure 6. Tighten attaching screw firmly.

3. Place new O-ring seal in groove in inner side of end cover. With end cover in place against end frame, install seven attaching cap screws and lock washers. Tighten cap screws firmly.

4. Make sure drain plug is installed and securely tightened in bottom of diode end frame. Plug oil inlet opening in top of diode end frame to keep out dirt until generator is installed.

BEARING OR ROTOR REPLACEMENT

Whenever the rotor and drive end frame are disassembled for any reason, the single row ball bearing must be replaced with a new one due to the probability of its being damaged during disassembly. Refer to figure 9 for assembled view.

REMOVAL AND DISASSEMBLY

1. If driven gear was not removed from rotor shaft at time of generator removal, remove nut and flat washer from shaft and pull gear off shaft.

2. Remove six bolts and lock washers attaching drive end frame to stator frame. Separate drive end frame from stator frame and remove drive end frame and rotor assembly.

3. Support drive end frame in arbor press in such a manner that the rotor can be pressed down out of end frame. Using a suitable adapter against end of rotor shaft which will pass through the inner race of the double-row ball bearing, press rotor down out of end frame and bearings.

4. Remove six screws attaching bearing retainer plate to drive end frame. Remove retainer plate.

5. Support drive end frame in arbor press, with double-row bearing up, in such a manner that the bearings can be pressed down out of end frame. Using a suitable driver which will exert force on both the inner and outer races of the double-row bearing, press bearings downward out of end frame. (The bearing spacer transmits force from the double-row bearing inner race to the inner race of the single-row bearing; since this force is transmitted to the single-row bearing outer race through the balls, the bearing is likely to be damaged and must be replaced with a new part.)

6. Remove rubber bearing clamp from groove in end frame bearing bore.

ASSEMBLY AND INSTALLATION

1. Press new single-row ball bearing into inner side of drive end frame. Install bearing retainer plate and attach with six screws. Stake screws in place after tightening.

2. Position rubber bearing clamp in groove in bearing bore in drive end frame. Lubricate clamp to permit bearing to be pressed in without dislodging or damaging the clamp.

3. Position rotor in arbor press with shaft end up. Install drive end frame and single-row bearing assembly over rotor shaft. Using a driver over rotor shaft which will exert force on the bearing inner race, press bearing onto shaft until it bottoms against the rotor.

4. Install bearing spacer over rotor shaft. Position double-row bearing over rotor shaft at end frame bore. Using an adapter which will exert force on both the inner and outer races of the bearing, press bearing onto shaft and into end frame until inner race bottoms against bearing spacer.

5. Place new O-ring seal in notch around drive end of stator frame.

6. Insert the rotor between the stator and field, and position drive end frame against stator frame. Attach end frame to stator frame with six bolts and lock washers. Tighten bolts firmly.

SPECIFICATIONS

Make	Delco-Remy
Model Number	1117681
Rotation	Either
Field Current @ 80° F.	
Amperes	8.1-8.45
Volts	12
Hot Output	
Amperes	300
Volts	14
Approximate Engine RPM	1500
Generator Drive Ratio	2.29 to 1

Regulator

GENERAL

The transistor regulator used on all vehicles covered by this manual is an assembly composed principally of diodes, condensers, resistors, and transistors. These components are mounted on a printed circuit panel board to form a completely static unit containing no moving parts. Regulator terminal connections are marked "NEG," "FLD," and "POS."

The regulator components work together to limit the generator voltage to a pre-set value by controlling the generator field current. This is the only function the regulator performs in the charging circuit.

The voltage at which the generator operates is determined by the regulator adjustment. Once adjusted, the regulator voltage remains constant, since the regulator is unaffected by length of service, changes in temperature, or changes in generator output and speed.

The primary controlling device for the regulator is the Zener diode (D2). The Zener diode is used as a reference source to sense increasing voltage and to turn on the driver transistor (TR2) which in turn shuts off the power transistors (TR1).

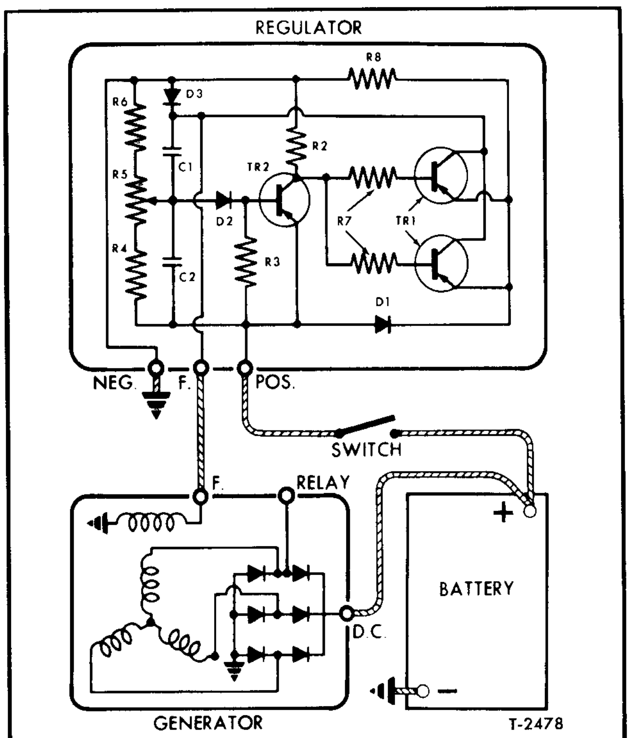
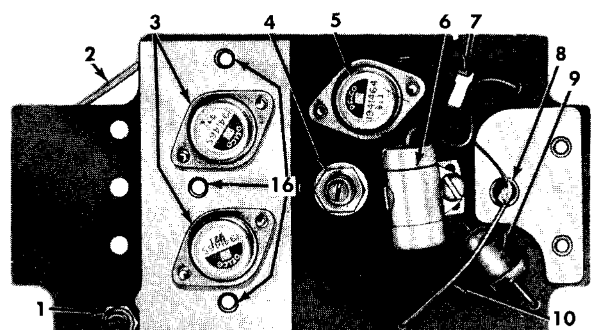


Figure 1—Regulator Circuitry Diagram

With power transistors (TR1) shut off, field current drops until system voltage drops sufficiently to cause the Zener diode (D2) to again allow full field application by the transistors. This action occurs at a varying frequency, depending on generator speed and load.

CAUTION: When performing maintenance on generator or regulator, NEVER ALLOW REGULATOR LEADS TO BECOME GROUNDED.

Figure 1 shows regulator circuitry with each major component identified. Figure 2 shows corresponding items in actual location on panel board in respect to circuitry diagram (fig. 1).



1 Field Discharge Diode (D3)
2 Wire Wound Resistor (R2)
3 Power (Output) Transistors (TR1)
4 Potentiometer (R5)
5 Driver Transistor (TR2)
6 Feed-Back Condenser (C1)
7 Zener Diode (D2)
8 Back-Bias Diode (D1)
9 Filter Condenser (C2)
10 Feed Back Connection
11 Wire Wound Resistor (R4)
12 Wire Wound Resistor (R3)
13 Wire Wound Resistor (R8)
14 Wire Wound Resistor (R7)
15 Wire Wound Resistor (R6)
16 Insulators

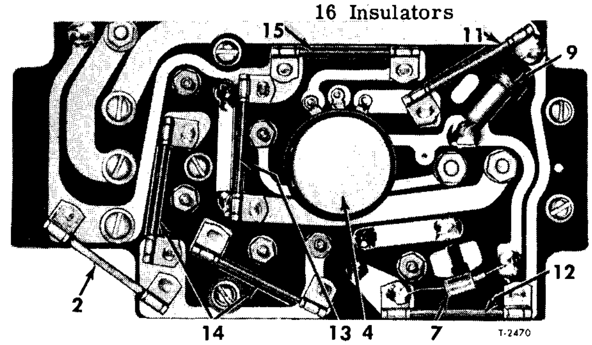


Figure 2—Regulator Components

Regulator is mounted in the battery compartment apparatus box as shown in figure 7 in "WIRING AND MISCELLANEOUS ELECTRICAL" section. Accessibility to regulator is also described in the same section.

ON VEHICLE ADJUSTMENT

Trouble in the electrical system will usually be indicated by one of two conditions - an undercharged or an overcharged battery. Either condition can result from an improper regulator setting.

The ideal voltage setting is the one which will maintain the batteries in a fully charged condition with a minimum use of water. This setting must be determined by the operator according to the particular type of service under which the coach operates. Check and adjust voltage regulator setting as follows: (See fig. 3 for voltmeter connections.)

1. Connect a voltmeter from regulator "POS" terminal to ground.
2. Start engine and operate at approximately 1000 rpm (about 2300 generator rpm).
3. Turn on vehicle blower motors.
4. Observe voltmeter; a steady reading of 13.7 volts should appear. If this reading is not present, remove plug from regulator and adjust potentiometer (fig. 4) until reading is obtained.

NOTE: In some cases, when maximum special electrical equipment is used and an undercharged battery condition results over a period of time, it may be necessary to adjust regulator to 14 volts. If this is the case, operate vehicle a minimum service period of 48 hours and check for an improved battery condition. The same procedure applies for an overcharged battery, except adjust voltage to 13.4 volts.

5. If voltage cannot be adjusted by turning potentiometer, and it is evident that trouble exists in generating system, check generator as directed in "GENERATOR" section of this manual. If generator is found to be satisfactory, check regulator as directed under "Troubleshooting" below.

TROUBLESHOOTING

Various electrical checks can be made to locate defective components. Components to be checked are identified in figure 2.

The ohmmeter used in the following checks must be accurate, and must be one which uses a 1-1/2 volt dry cell. The milliammeter and voltmeter used in figure 5 are as follows: Milliammeter - use the milliammeter ranges of a Simpson Model 260 Multimeter, or any reliable 0-100 milliampere D.C. meter; voltmeter - use the voltmeter range of a Simpson Model 260 Multimeter, or any 0-15 voltmeter with 10,000 ohms/volt or higher movement. The spare potentiometer used in figure 5 is a 30-ohm, 10-watt unit (part number 1941477).

When making checks, note carefully in the illustrations how the ohmmeter is connected with regards to polarity, and select a scale applicable to check being made.

POLARITY OF OHMMETER MUST BE DETERMINED BEFORE FOLLOWING CHECKS ARE MADE.

To determine polarity of ohmmeter, connect one lead to a known positive (+) lead of a voltmeter and other lead to negative (-) lead of voltmeter. If voltmeter reads up-scale, ohmmeter positive (+) lead is connected to voltmeter positive (+) lead and ohmmeter negative (-) lead is connected to voltmeter negative (-) lead.

It is important that the following checks be made in the order listed. If a defective part is found, replace it before proceeding with the remaining checks. Be sure to make all the checks as

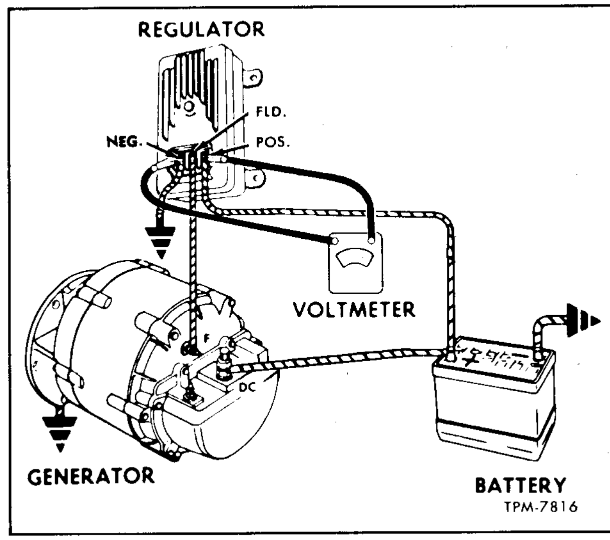


Figure 3—Checking Regulator Voltage Setting

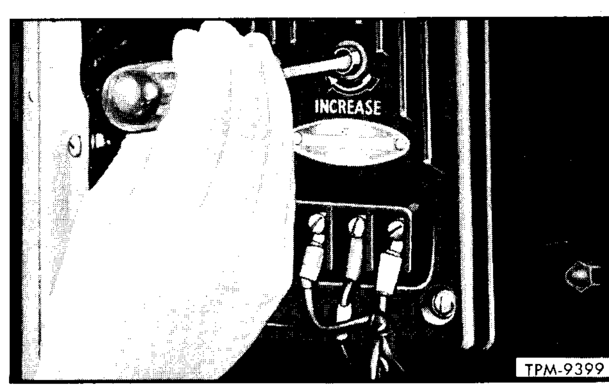


Figure 4—Adjusting Voltage Regulator

REGULATOR

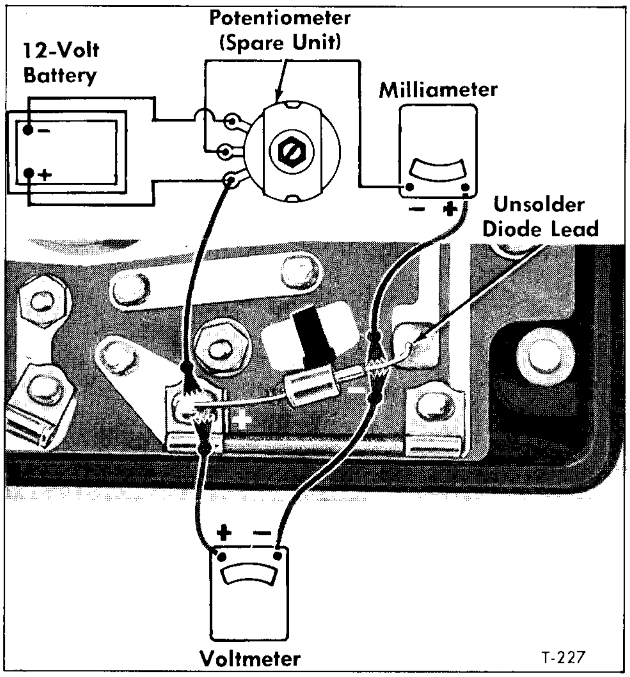


Figure 5—Meter Connections For Checking Zener Diode

more than one component may be defective.

A defective part may be replaced by removing any attaching screws involved and/or unsoldering the connections. To replace the parts identified in figure 2, separate the printed circuit board from the cover by removing eight attaching screws. When resoldering, limit solder time to a minimum, as excessive heat may damage the printed circuit and component parts. However, good soldered connections are essential for satisfactory operation. Any good grade of radio-type rosin core solder is recommended. Use soldering iron having sufficient heating capacity to solder or unsolder connection quickly.

ZENER DIODE

To check the Zener diode (7, fig. 2), unsolder the diode lead and lift up just enough to separate from the printed circuit; bending lead too far may cause it to break off inside the diode. Connect instruments as shown in figure 5, then check as follows: Do not attempt to use potentiometer in regulator. Use spare unit.

1. Start with potentiometer at extreme clockwise position.
2. With ammeter set at appropriate scale, rotate potentiometer until milliammeter reads 2

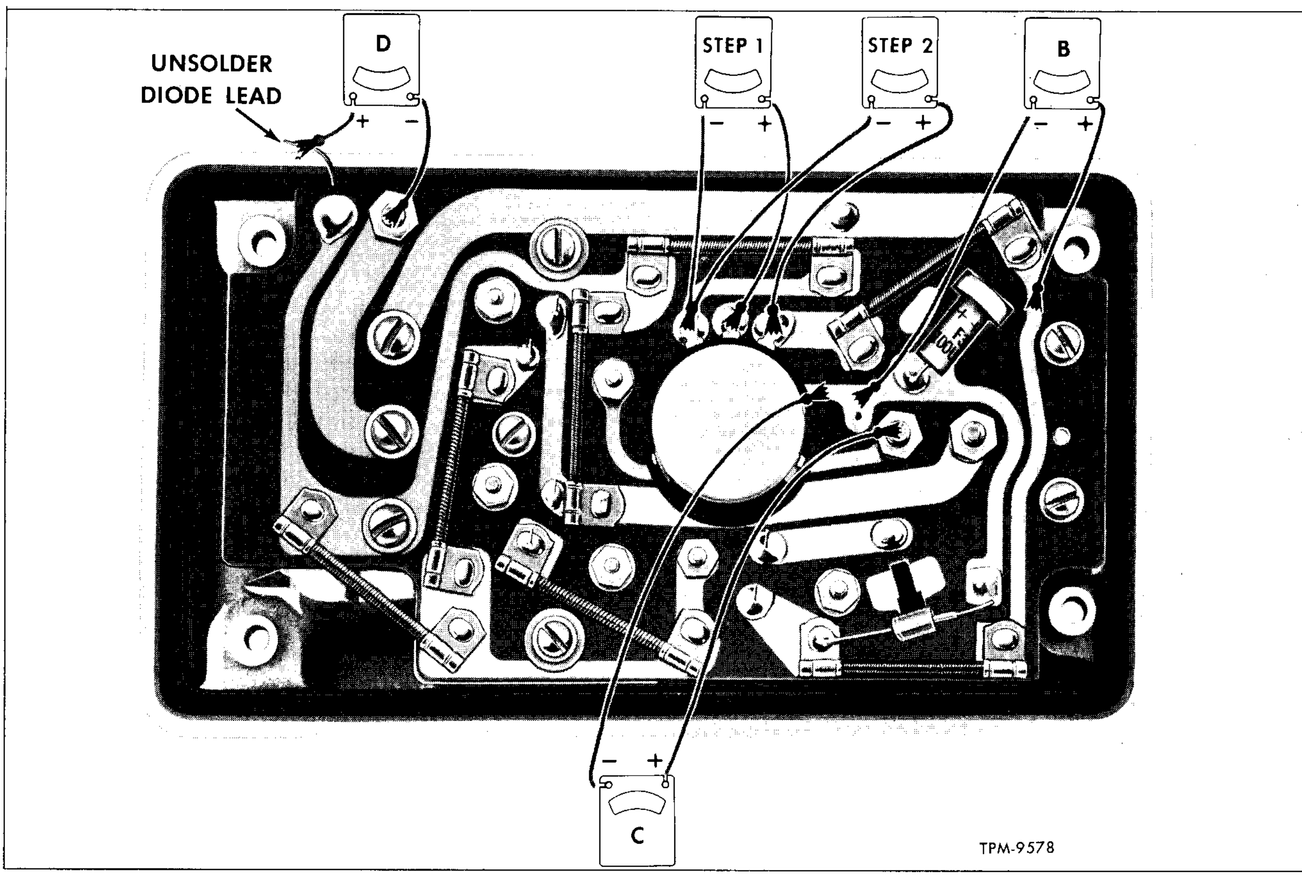


Figure 6—Regulator Component Checks

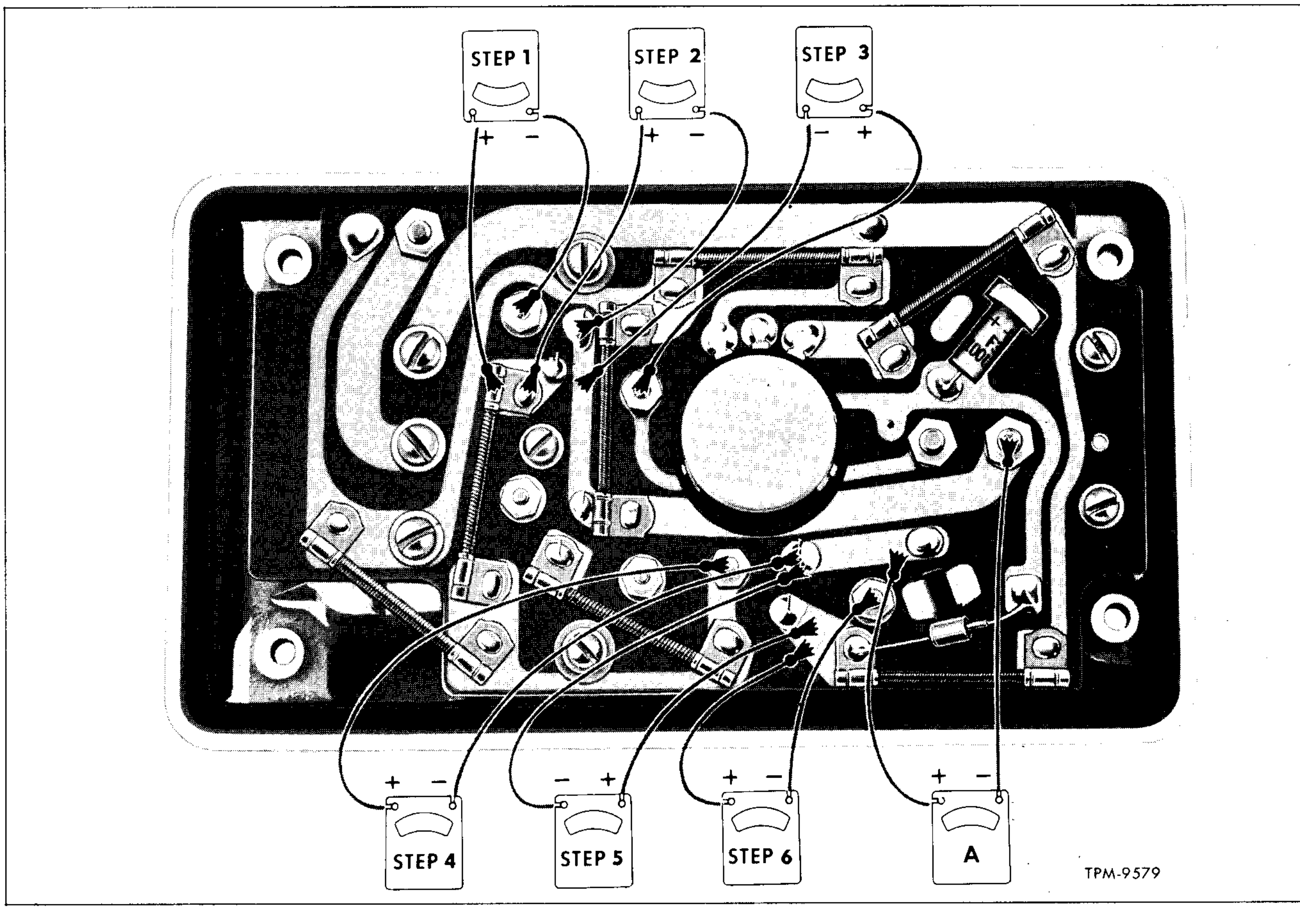


Figure 7—Regulator Component Checks

milliamperes. Read voltmeter - limits are 7.4 volts minimum, 10.0 volts maximum.

3. Rotate potentiometer until milliammeter reads 50 milliamperes. Voltmeter reading must not increase more than 0.5 volt above reading in step 2.

POTENTIOMETER

To check the potentiometer (4, fig. 2), connect ohmmeter leads as shown in Steps 1 and 2 of figure 6. If either reading is 100 ohms or above, potentiometer is open.

FILTER CONDENSER

To check the filter condenser (9, fig. 2), connect ohmmeter leads as shown in Part "B" of figure 6. A zero ohm reading indicates a shorted filter condenser. To check for opens, inspect the two soldered connections for breaks.

FEED-BACK CONDENSER

To check the feed-back condenser (10, fig. 2), connect ohmmeter leads as shown in Part "C" of figure 6. If a zero ohm reading is obtained, condenser is shorted. To check for opens, inspect the soldered connection.

FIELD DISCHARGE DIODE

To check the field discharge diode (1, fig. 2), unsolder lead and connect ohmmeter leads as shown in Part "D" of figure 6. If a zero ohm reading is obtained, diode is shorted. If a very high (infinite) reading is obtained, diode is open.

NOTE: Before proceeding with other check, resolder diode lead.

BACK BIAS DIODE

To check the back bias diode (8, fig. 2), connect ohmmeter leads as shown in Part "A" of figure 7. A zero ohm reading indicates a shorted diode, and a reading over 100 ohms indicates an open diode.

POWER TRANSISTORS

Shorted Transistor

Check the power transistors (3, fig. 2), by connecting the ohmmeter the three ways shown in Steps 1, 2, and 3 of figure 7. If any reading is zero ohms, one of the power transistors is shorted. To determine which power transistor is shorted, or if both transistors are shorted, remove the upper transistor (3, fig. 2) and repeat the check as

REGULATOR

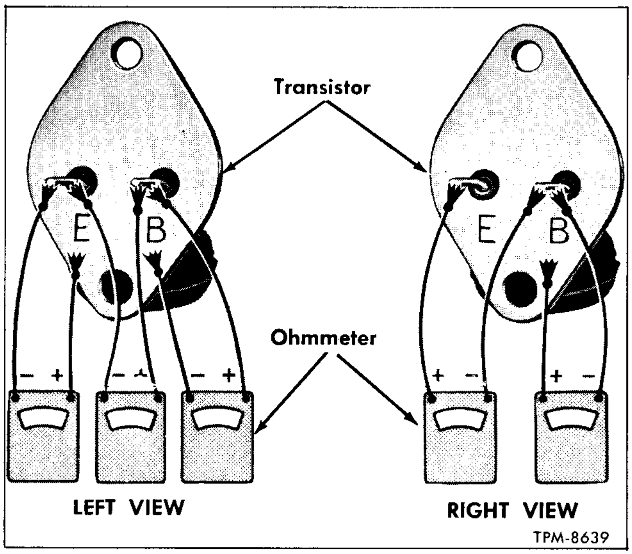


Figure 8—Checking Transistors Removed From Panel Board

shown in figure 7 on the transistor which is still mounted on the printed circuit board. If any of the three readings is zero, the transistor is shorted. Also check the transistor which has been removed by connecting the ohmmeter the three ways shown in left view of figure 8. A zero reading in any one of the three checks indicates a shorted transistor.

Open Transistor

Check power transistors for opens by removing transistor from panel board and connecting ohmmeter to each transistor as shown in right view of figure 8. A very high (infinite) reading in either check indicates an open transistor.

DRIVER TRANSISTOR

Shorted Transistor

Check the driver transistor (5, fig. 2) by connecting ohmmeter as shown in steps 4, 5, and 6 of figure 7. The transistor being checked is shorted if a zero ohm reading is obtained.

Open Transistor

Check the driver transistors for opens as explained under "Power Transistors."

REGULATOR SPECIFICATIONS

Make	Delco-Remy
Type	Transistorized
Model Number	9000551
Polarity	Negative Ground
Quantity of Transistors	
Power (output)	2
Driver	1
Voltage Setting	13.7 (see text)

Lighting System

GENERAL

Circuits for all lights used for regular illumination purposes are shown on "Coach Lighting Wiring Diagram" (MD-98684). Circuits for directional signals and tell-tale light are shown on "Directional Lamp Wiring Diagram" (MD-97599). Circuits for stop lights and tell-tale light are shown on "Alarm and Signal Wiring Diagram" (MD-97596).

IMPORTANT: All lights should be checked daily and necessary replacements made. Bulb sizes are listed in "Specifications" at end of this section.

SWITCHES AND CIRCUIT BREAKERS

The following lights are controlled by switches located on the driver's instrument panel.

1. Reading and general lights.
2. Destination sign lights.
3. Michigan and corner marker lights.
4. Emergency flashing lights.
5. Headlamps, license and tail lights.

Driver's lamp and seat lights (if used) are controlled by switches located on the driver's control panel at left of driver. Directional lights are controlled by switch on steering column.

Engine compartment, baggage compartment, lavatory, front step, and refrigerant receiver tank lights are controlled by secondary switches operated by door or manually.

All lighting circuits are protected by automatic reset type circuit breakers. Location and rating of all the circuit breakers are covered in "WIRING AND MISCELLANEOUS ELECTRICAL" section at beginning of this group.

EXTERIOR LIGHTING EQUIPMENT

HEADLIGHTS

Each headlight consists of two 5-3/4-inch Type T-3 sealed-beam lamp units. Outer lights are double-filament units, having upper and lower beams. Inner lights are single-filament units, and are used only in conjunction with the upper beam of the outer units. The inner units are identified as Type 1 and have the numeral "1" molded in top of lens; the outer units are Type 2, with the numeral "2" molded in top of lens.

Type T-3 sealed-beam unit lens incorporate three projecting guide points which are optically ground to provide flat surfaces at right-angles to the light beam (fig. 1). This design permits adjustment of the light beams in daylight without the use of an aiming screen and without requiring a large work area. Aiming is accomplished with a "T-3 Safety Aimer, Type B" (J-6663). Instructions for using the T-3 aimers are supplied by the instrument manufacturer. Headlights can also be adjusted without the use of the mechanical aimer as follows:

AIMING PROCEDURE

Inner (High-Beam) Lights (Fig. 2)

1. Position vehicle on level floor with headlights 25 feet from a smooth vertical surface. Surface should be provided with paper or a panel which can be removed to permit drawing two sets of aiming lines. Centerline of vehicle must be at right-angle to the vertical surface.

2. Measure height of headlight centers from floor and mark this height on vertical surface. Draw a horizontal line A-A on vertical surface at this height. Draw a second horizontal line B-B parallel with and 2 inches below line A-A.

3. Locate point at which projected centerline of vehicle intersects these lines and draw a vertical line C-C.

4. Measure distance between centers of inner lights, then divide this distance equally on both sides of centerline C-C. Draw a vertical line (D-D and E-E) through each of these points.

5. Remove headlight trim panel for access to adjusting screws. Press "HEAD" switch to "ON" position and select high beam with dimmer switch. Cover all lights except one inner light.

6. The high intensity zone of the beam pattern should center at the point where vertical line (D-D or E-E) intersects horizontal line B-B. Turn ver-

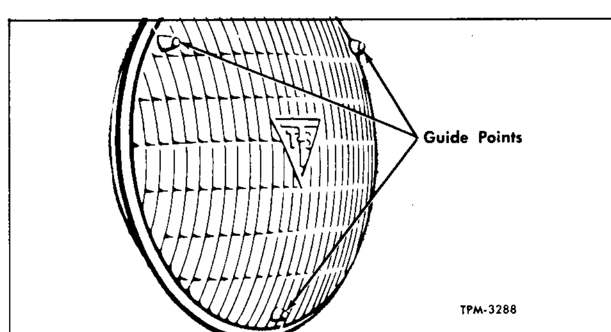


Figure 1—T-3 Headlight Sealed-Beam Unit

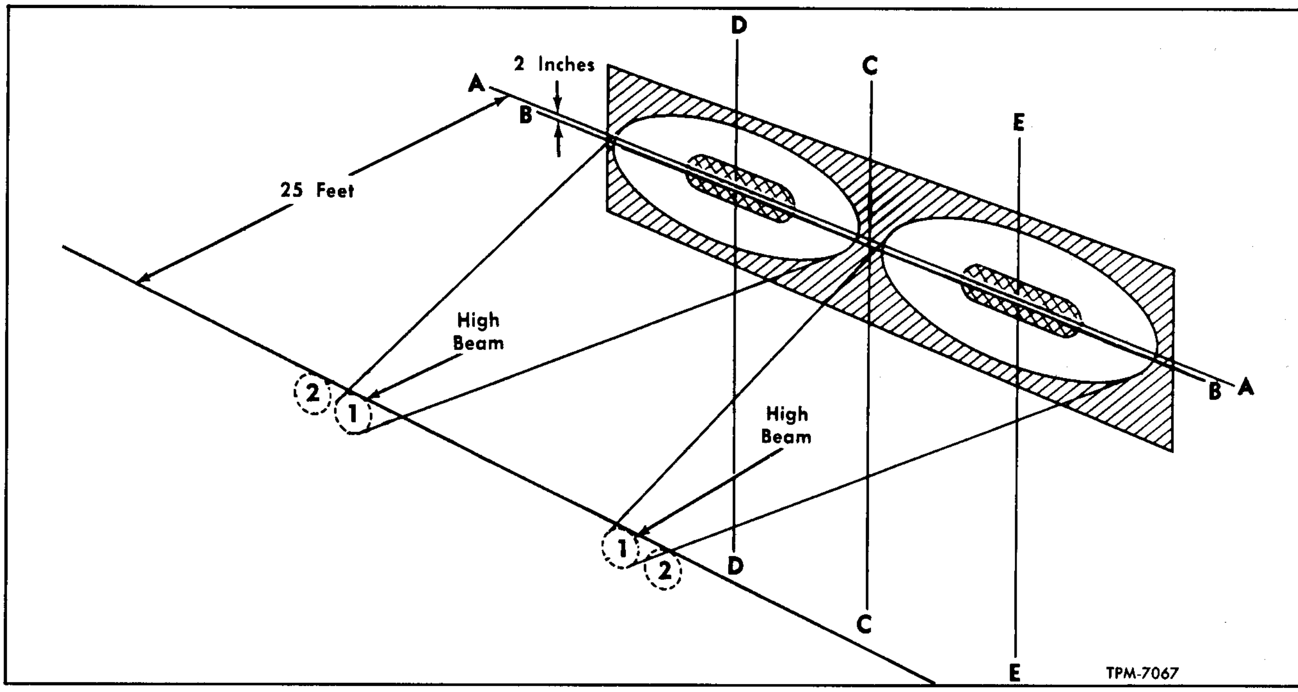


Figure 2—Inner Light (High Beam) Aiming Chart

tical adjusting screw (fig. 4) to raise or lower the beam pattern, and turn horizontal adjusting screw to move it to right or left.

7. After completing adjustment on one inner light, cover that light, uncover other inner light, and adjust in the same manner.

8. Remove paper or panel from vertical surface to permit drawing aiming lines for outer lights. NOTE: Lines A-A and C-C in figure 2 are in same location for figure 3 and can be located

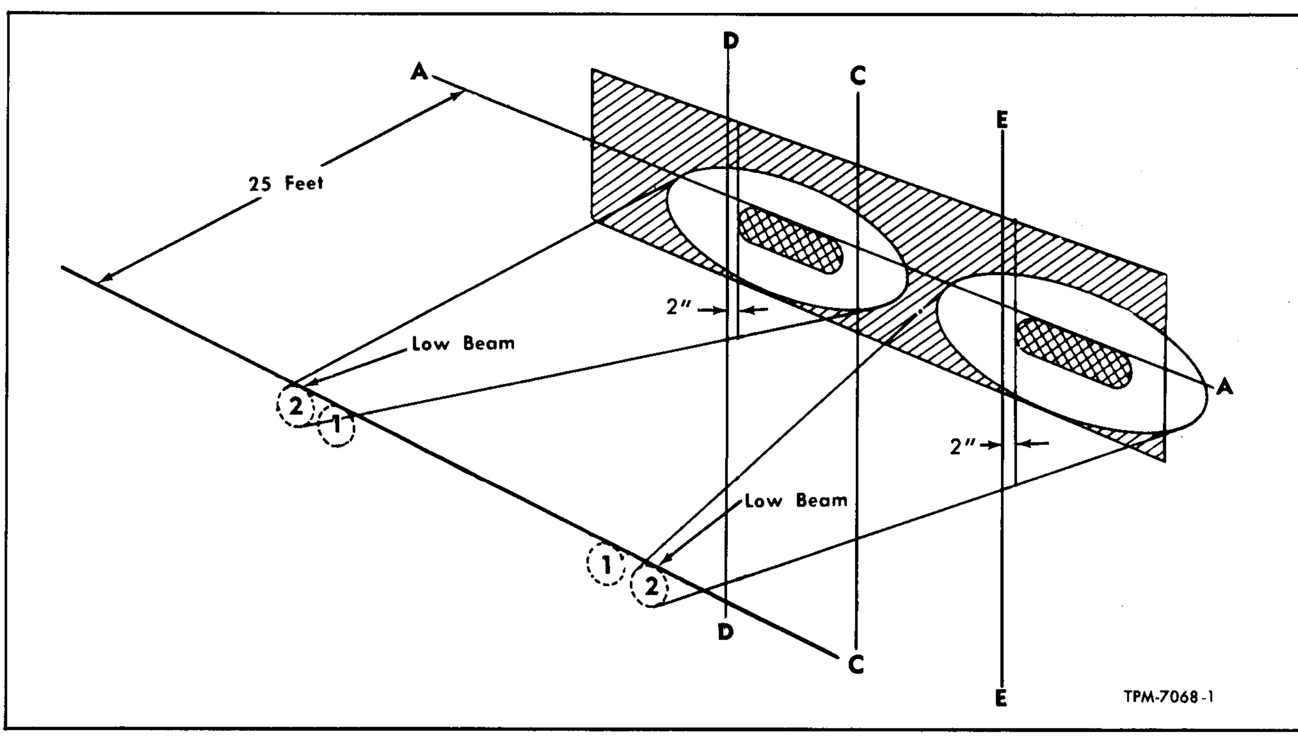


Figure 3—Outer Light (Low Beam) Aiming Chart

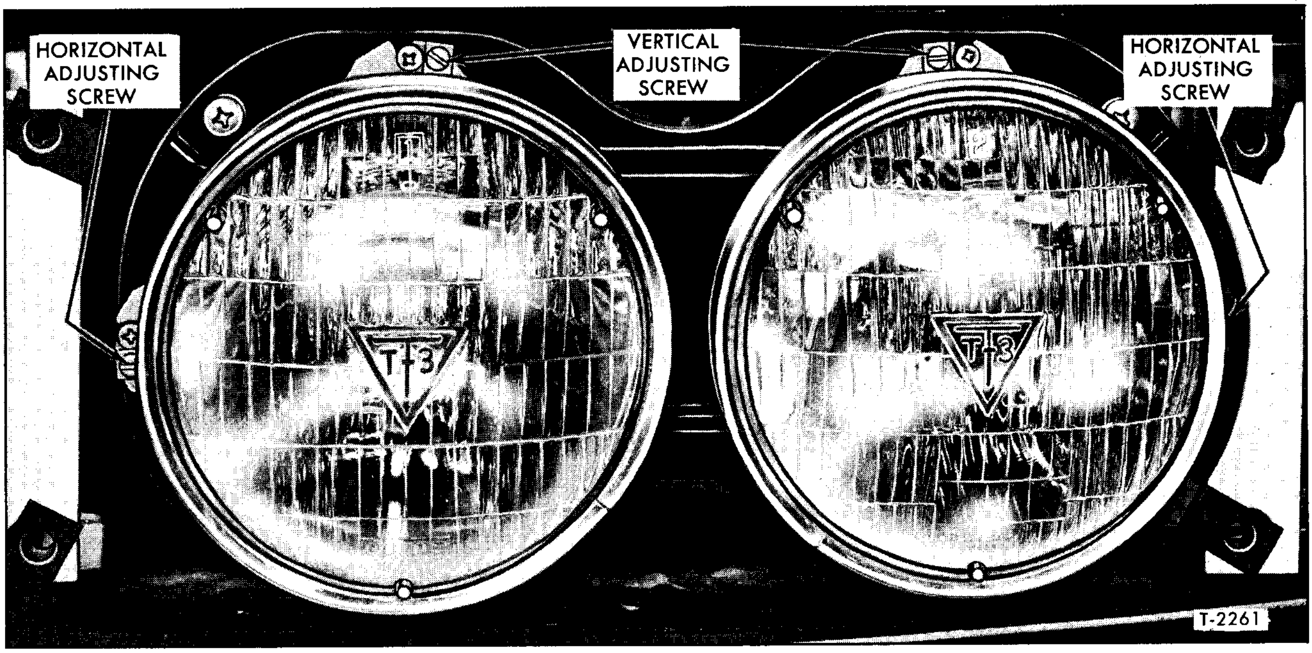


Figure 4—Headlight Adjusting Screws

on vertical surface in same place by taking measurements from the removed paper or panel.

Outer (Low Beam) Lights (Fig. 3)

1. Locate projected centerline of vehicle and height of headlight centers in same manner as in steps 2 and 3 under "Inner Lights," except that horizontal line B-B is omitted.
2. Measure distance between centers of outer lights and divide this distance equally on both sides of centerline C-C. Draw a vertical line (D-D and E-E) through each of these points.
3. Press "HEAD" switch to "ON" position and select low beam with dimmer switch (inner lights will not be illuminated). Cover one light while adjusting the other. The edge of the intensity zone of the beam pattern must be just below the horizontal centerline (A-A) and 2 inches to the right of the vertical centerline (D-D or E-E). Turn vertical or horizontal adjusting screws as necessary to obtain this condition.
4. After all lights are properly adjusted, install headlight trim panel.

SEALED-BEAM UNIT REPLACEMENT

Removal

1. Remove six screws attaching trim panel and remove panel.
2. Remove two screws attaching sealed-beam unit retaining ring to mounting ring.
3. Unhook spring from retaining ring and remove retaining ring.
4. Remove sealed-beam unit and pull wiring connector plug off back of unit.

Installation

NOTE: Sealed-beam unit with number "1" molded in top of lens must be used at inside lights. Unit with number "2" on lens must be used at outside lights.

1. Install wiring connector plug on back of sealed-beam unit. Position unit in mounting ring with lugs on back of unit engaging holes in mounting ring. Molded number on lens must be at top.
2. Position retaining ring over lens and secure to mounting ring with two screws.
3. Hook spring into hole in retaining ring.

NOTE: If headlight beam was properly adjusted before sealed-beam unit replacement, it is not necessary to adjust beam, providing adjusting screws were not removed. If adjusting screws were moved, adjust headlight beam as previously directed under "Aiming Procedure."

4. Install trim panel and attaching screws.

HEADLIGHT DIMMER SWITCH

A foot-operated switch located on floorboard near clutch pedal is used to select either the headlight upper or lower beam when headlights are being used. This switch is operative only when "HEAD" switch is placed in "ON" position.

Switch requires no maintenance; however, switch may be replaced by removing mounting screws, after which switch is readily accessible from under floor through tool compartment.

When installing foot-operated switch, connect wires to terminals before attaching switch to floor boards. IMPORTANT: No. 14 brown wire must be connected to switch terminal marked "BAT." Con-

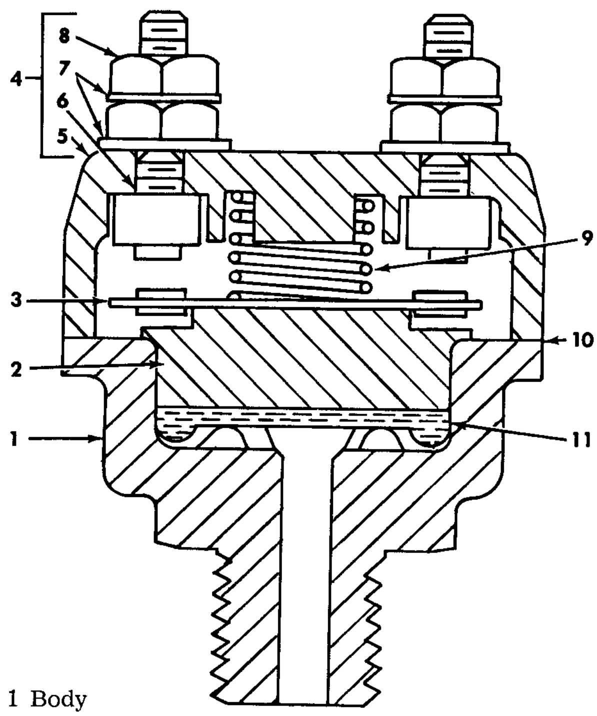


Figure 5—Stop Light Switch

nect other two wires to remaining terminals; position of these wires with respect to terminals is not important.

STOP, TAIL, EMERGENCY FLASHING, AND DIRECTIONAL LIGHTS

There are individual stop, tail, and directional lights. At the rear of coach, directional lights are to the outside and stop and tail lights are to the inside.

Optional directional signal lights are mounted to the rear of the front door and on the opposite left-hand side. These provide a more exposed signal to people who are at right angles to coach movement.

STOP LIGHT SYSTEM

Stop light system consists of two lights, air-operated switch mounted on the brake application valve, stop light relay mounted in the driver's control panel, and stop light tell-tale on driver's instrument panel. Stop light system is protected by No. 22 circuit breaker on apparatus panel at left of driver.

OPERATION

When brakes are applied and stop light switch is closed, the relay is energized and stop lights illuminate. Current through the relay contacts illuminates stop light tell-tale.

If either stop light is inoperative the tell-tale light will not illuminate.

BULB REPLACEMENT (AT REAR OF COACH)

Remove four screws securing lens to body. Remove lens. Turn bulb, remove, and replace. Before installing lens, examine gasket for collapsed or deteriorated condition and replace if necessary. Install lens and secure with four screws.

STOP LIGHT SWITCH (Fig. 5)

Stop light switch is an electro-pneumatic switch that is actuated by air pressure from the brake application valve when brakes are applied. 5 ± 2 psi air pressure on the piston (2) will overcome piston spring (9) tension. The contact strip (3) makes contact with the terminal screws (6) to complete the switching circuit that is in series with stop light relay and current source at the circuit breaker.

SWITCH REMOVAL

Remove terminal nuts and disconnect wires from switch terminals. Then, unscrew switch body (1, fig. 5) from brake application valve.

SWITCH REPAIR (Fig. 5)

Disassemble switch by removing two screws attaching cover assembly (4) to body. Remove spring (9), contact strip (3), piston (2), O-ring diaphragm (11), and cover gasket (10). Clean all metal parts in cleaning solvent. Examine diaphragm and cover gasket. If diaphragm is cracked, worn or damaged, replace with new diaphragm. Inspect contact points for pitting or wear. If pitting is not too severe, file them with a fine file such as is used on distributor points. If they cannot be reconditioned, replace them. Check piston spring tension. If it has lost its tension, replace it. If the body threads are worn or stripped, replace body. Reassemble switch and tighten cover-to-body screws firmly.

SWITCH INSTALLATION

Thread switch into application valve and tighten firmly. Connect wires to switch terminals. With air pressure in system, apply brakes and check operation of stop lights.

Stop Light Tell-tale Relay

Operation, maintenance, and adjustment of stop light tell-tale relay are described under "Relays" in "WIRING AND MISCELLANEOUS ELECTRICAL" section at beginning of this group.

TAILLIGHT SYSTEM

Taillights are mounted in engine compartment door between stop and directional signal lights. Taillight circuit is protected by No. 14 circuit breaker on apparatus panel at left of driver.

OPERATION

Taillight circuit is energized when "HEAD" switch on driver's instrument panel is in the "ON" position.

BULB REPLACEMENT

Taillight bulbs are accessible and replaceable in same manner previously described under "Bulb Replacement (At Rear of Coach)."

LICENSE PLATE LIGHTS

Two license plate lights, mounted directly above license plate, are used to illuminate license plate. Lights are operative when "HEAD" switch is placed in "ON" position. Lights are protected by No. 14 circuit breaker on apparatus panel at left of driver. Electrical circuit for lights is shown on "Coach Lighting Wiring Diagram." To replace defective bulb, remove two screw attaching mounting bracket, pull bracket and lamp assembly out enough to remove two screws attaching cover to back plate. With cover and lens removed, replace defective bulb.

DIRECTIONAL SIGNAL SYSTEM

Directional signal system consists of two lights located on engine compartment door at rear of coach, two lights on front of coach, and on some coaches two front side lights. Directional signal system is controlled by directional signal switch located on steering column and flasher unit located on heater and defroster right-hand side panel. See figure 10 in "WIRING AND MISCELLANEOUS ELECTRICAL."

Operation

When directional signal switch is placed in up or down position (right or left turn), circuit is completed from flasher unit "L" terminal through switch and pilot relays to front and rear directional lights. Directional signal system is protected by No. 17 circuit breaker on apparatus panel at left of driver.

BULB REPLACEMENT (FRONT OF COACH)

Rear directional light bulbs are replaced in the same manner as previously described under "Bulb Replacement (At Rear of Coach)." Front directional bulbs are removed from the lamp assemblies as follows:

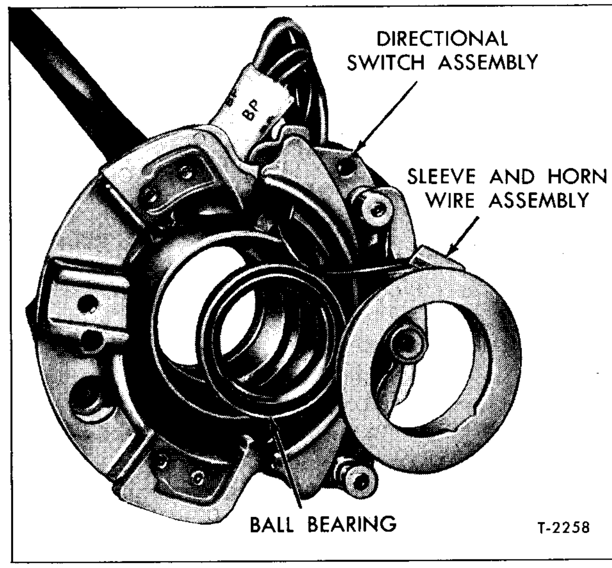


Figure 6—Directional Switch Assembly

1. Remove four screws securing lens to lamp housing.
2. Remove lens and replace bulb.
3. To inspect gasket, remove three mounting screws and remove lamp housing. If deteriorated or cracked, replace gasket.

Side directional light bulbs (if used) are accessible after removing guard and removing two screws attaching retainer and lens. Remove and replace bulb.

DIRECTIONAL SIGNAL SWITCH (Fig. 6)

Directional signal switch is a self-cancelling switch mounted on the steering column below the steering wheel. Pushing lever up (forward) turns on right front and rear directional lamps; down (rearward) position turns on left front and rear directional lamps. When turn is completed, switch automatically returns to "OFF" position.

Removal

1. Remove steering wheel as directed in "Steering Wheel Replacement" in STEERING (SEC. 16).

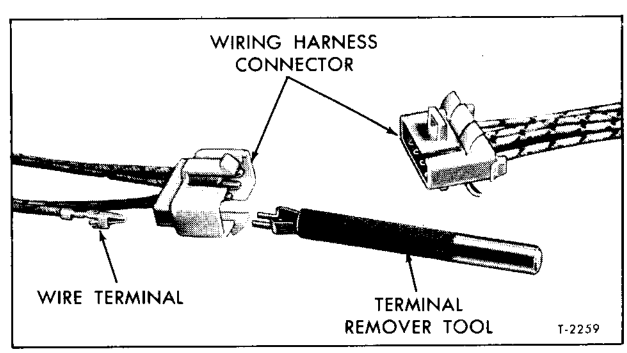


Figure 7—Removing Terminals From Connector

2. Disconnect directional signal switch cable assembly connector from chassis wiring harness connector. Use Electrical Terminal Remover (J-21091) (fig. 7) to remove wire terminals from cable connector.

3. Remove screw attaching control lever to switch, then remove lever.

4. Remove three screws attaching signal switch assembly to housing and remove switch assembly.

Inspection

1. Inspect sleeve and horn wire assembly. If worn or damaged cut horn wire and use suitable puller to remove sleeve. (Sleeve and horn wire are serviced only as an assembly.) Replace sleeve and tape new horn wire to existing cable loom.

2. Inspect ball bearing. If worn or damaged, use suitable puller to remove sleeve. Remove and replace ball bearing.

3. Inspect switch, cable, spring and body. If damaged or worn, replace complete unit.

Installation

1. Position directional signal switch assembly on steering column and attach to housing with three screws.

2. Position control lever on switch assembly and attach with screw. Tighten screw firmly.

3. Connect directional signal switch cable assembly connector to chassis wiring harness connector.

4. Install steering wheel as directed in "Steering Wheel Replacement" in STEERING (SEC. 16).

Directional Signal Tell-Tale Relays

Location and function of directional signal tell-tale relays are described under "Relays" in "WIRING AND MISCELLANEOUS ELECTRICAL" section at beginning of this group.

EMERGENCY FLASHING SYSTEM

Emergency flashing system consists of two directional lights at rear of coach, two directional signal lights at front of coach, and on some coaches, two side directional signal lights. System is operated by "EMERGENCY FLASHING" switch located on driver's instrument panel and flashing cycle is controlled by flashing unit mounted on heater and defroster right-hand side panel. See figure 10 in "WIRING AND MISCELLANEOUS ELECTRICAL" section at beginning of this group. Emergency flashing system circuit is shown on "Directional Lamp Wiring Diagram."

Operation

When "EMERGENCY FLASHING" switch is placed in the "ON" position, circuit is completed from "L" terminal of flasher unit through switch and pilot relays to directional signal and directional tell-tale lights. Lights flash at a steady cycle until switch is placed in "OFF" position.

Flasher unit is protected by No. 17 circuit breaker on apparatus panel at left of driver.

Switch

Emergency flasher switch is a double-pole double-throw rocker type switch, and is secured to driver's instrument panel with a self-tapping screw. To remove switch, remove screw, pull switch from under dash and disconnect four wires.

IMPORTANT: Make sure wires are clearly identified before removing from switch to insure proper position when installing switch.

CORNER MARKER LIGHTS

A marker light is mounted at each corner of coach near top. Marker light circuits are energized with "MARKER" switch in "ON" position. Circuit is protected by No. 15 circuit breaker on apparatus panel at left of driver. Light bulbs are accessible for replacement after removing lens. Each lens is attached to body with two screws.

IDENTIFICATION LIGHTS (MICHIGAN MARKER)

Six identification lights (Michigan Marker) are mounted - three at rear of coach above window and three at front of coach above destination sign. Light circuits are energized when "MARKER" switch is placed in "ON" position. Circuit is protected by No. 15 circuit breaker located on apparatus panel at left of driver. Rear light bulbs are accessible for replacement after removing screw attaching lens to body. Front light bulbs are accessible by lowering front destination sign door. Pull socket from lamp body and replace bulb.

FRONT DESTINATION SIGN LIGHTS

Four front destination sign lights, mounted behind destination sign curtain, provide illumination for destination sign. Lights are controlled by "SIGN" switch on driver's instrument panel and are protected by No. 16 circuit breaker on apparatus panel at left of driver. When "SIGN" switch is placed in "ON" position, sign is illuminated. Refer to "Coach Lighting Wiring Diagram" for electrical circuit. Bulbs are accessible for replacement from inside coach after lowering sign and door, then lifting top curtain roller from bearing at right side.

SIDE DESTINATION SIGN LIGHTS

Two side destination sign lights, mounted behind destination sign curtain on right side of coach, provide illumination for side destination sign used as special equipment on some coaches. Lights are

controlled by "SIGN" switch and are protected by No. 16 circuit breaker on apparatus panel at left of driver. When "SIGN" switch is placed in "ON" position, sign is illuminated. Refer to "Coach Lighting Wiring Diagram" for electrical circuits. Replacement of light bulbs is as follows:

BULB REPLACEMENT

Removal

1. Remove screws attaching lower portion of sign box.

2. Slide lower portion of sign box down and away until bulb access is gained.

3. Remove defective bulb(s) from socket by pushing inward and turning counterclockwise.

Installation

1. Insert new bulb(s) in socket, pushing inward, and turning clockwise.

2. Slide lower portion of sign box up and in until properly seated against upper portion.

3. Install attaching screws.

INTERIOR LIGHTING EQUIPMENT

INSTRUMENT PANEL LIGHTS

Gauges on instrument panel in front of driver are illuminated when "MARKER" switch is placed in "ON" position. Instrument panel lights are protected by No. 15 circuit breaker on apparatus panel at left of driver. Electrical circuit for lights is shown on "Coach Lighting Wiring Diagram."

Light bulbs are accessible by pulling bulb socket free from back of panel. Bulb can then be removed from socket. After replacing bulb, press socket firmly into back of panel housing.

STEPWELL LIGHT

Entrance door stepwell is illuminated by light mounted in lower dash panel. Light circuit is controlled by "ENGINE" switch on driver's instrument panel. With switch in "RUN" position, engine run magnetic switch is energized, completing circuit to entrance door switch. This circuit is protected by No. 2 circuit breaker on apparatus panel at left of driver. When entrance door is opened, entrance door switch contacts then close and completes circuit to light. The entrance door control mechanism switch is located under dash panel at right of driver. Control mechanism is illustrated in BODY (SEC. 3). Circuit for stepwell light is shown on "Coach Lighting Wiring Diagram."

To replace bulb, remove two mounting screws and nuts attaching cover and lens to body. Remove and replace bulb.

GENERAL AND READING LIGHTS

General interior and reading lamps are mounted on package rack edges, and are controlled by "READING" switch on driver's instrument panel.

GENERAL LIGHTS

With switch in "GEN." position, circuit through general lamp magnetic switch in battery compartment apparatus box is energized. This circuit is protected by No. 13 circuit breaker on apparatus panel at left of driver. Magnetic switch points then close and completes circuits to lights. Magnetic switch-to-light circuits are protected by circuit breakers in battery compartment apparatus box; No. 5 circuit breaker protects right side light circuit, and No. 4 circuit breaker protects left side light circuit.

READING LIGHTS

With switch in "READ" position, circuit through reading lamp magnetic switch in battery compartment apparatus box is energized. This circuit is protected by No. 13 circuit breaker on apparatus panel at left of driver. Magnetic switch points then close and completes circuit to lights. Reading lights can then be turned on by individual switches located in base of lamp. NOTE: Two front lamps are controlled by switches on No. 2 posts. Magnetic switch-to-light circuits are protected by circuit breakers in battery compartment apparatus box; No. 3 circuit breaker protects right side light circuit, and No. 2 circuit breaker protects left side light circuit. Refer to "Coach Lighting Wiring Diagram" for general and reading light circuitry.

BULB REPLACEMENT

Removal

1. Remove two cover retaining screws at top of package rack and remove bottom cover.

2. Remove defective reading lamp bulb(s) from socket by pushing inward and turning counterclockwise.

3. To remove general lighting bulb, pull switch mounting bracket down at snap end. Bulb is now accessible. Push inward and turn counterclockwise to remove bulb.

Installation

1. Insert new general lighting bulb in socket, and push bracket up until it snaps into position.

2. Insert new reading lamp bulb(s) in socket, push in and turn clockwise.

3. Replace bottom cover and attach with retaining screws at top of package rack.

NIGHT LAMPS

Two night lamps are mounted - one on the left front seat to illuminate the step and one on the left rear seat to illuminate the lavatory entrance. Lamps are illuminated when "MARKER" switch on driver's instrument panel is placed in the "ON" position. Circuit is protected by No. 13 circuit breaker located on apparatus panel at left of driver. Bulbs are accessible through hooded opening in front of lamp. A third night lamp located on second seat left hand side is controlled by entrance door switch. Refer to "WATCH STEP" SIGN LIGHTS later in this section for electrical circuitry.

DRIVER'S LAMP

Driver's lamp, mounted on trim panel above driver's window, is controlled by "DRIVER'S LAMP" switch on driver's control panel. Driver's lamp circuit is protected by No. 21 circuit breaker on apparatus panel at left of driver, and is shown on "Coach Lighting Wiring Diagram." Bulb is accessible after removing retainer and lens which is secured to lamp body with three screws.

GAUGE AND TELL-TALE LIGHTS

Gauge and tell-tale light bulbs are mounted in bulb sockets which snap into the gauge and tell-tale housings on under side of panel. Operation of tell-tale lights is explained under "Gauge, Switch and Tell-tale Panel" in "WIRING AND MISCELLANEOUS ELECTRICAL" section of this group. To replace any bulb, pull bulb socket out of opening in housing. After replacing bulb, press bulb socket firmly into housing.

BAGGAGE COMPARTMENT LIGHTS

Baggage compartment lights are controlled by individual switches as each door is opened and closed. Compartment light circuit is protected by No. 18 circuit breaker on apparatus panel at left of driver. Refer to "Coach Lighting Wiring Diagram" for electrical circuits. To replace bulbs, remove two mounting screws. Pull bulb and socket from body and replace bulb.

REFRIGERANT LEVEL SIGHT GLASS LIGHT

Refrigerant level sight glass light, controlled by either left or right front baggage compartment switch, is mounted in bracket on top of receiver tank assembly. Circuit is protected by No. 18 circuit breaker in driver's control panel and is shown on "Coach Lighting Wiring Diagram." Bulb is accessible for replacement by pulling socket from mounting bracket. Remove bulb by pushing in and turning counterclockwise.

ENGINE COMPARTMENT LIGHTS

Engine compartment lights are controlled by a switch on engine compartment apparatus box. Compartment light circuit is protected by No. 3 circuit breaker in engine compartment apparatus box. Refer to "Coach Lighting Wiring Diagram" for electrical circuits. Bulbs are exposed and are readily accessible for replacement.

"WATCH STEP" SIGN LIGHTS

"Watch Step" sign lights located in padded ledge beneath "Astrolite" and night lamp located on second seat, left hand side, are controlled by "ENGINE" switch on driver's instrument panel. With switch in "RUN" position, engine run magnetic switch is energized, completing circuit to entrance door switch and through relay points to lights. This circuit is protected by No. 2 circuit breaker on apparatus panel at left of driver. With entrance door opened, entrance door switch contacts close completing circuit through flasher relay coil. With flasher relay energized, circuit is completed through flasher to lights. Lights flash at a steady cycle until entrance door is closed.

To replace bulbs in "WATCH STEP" sign, snap lens out of housing and pull bulbs from retaining clips.

LAVATORY COMPARTMENT LIGHTS

DOME LIGHTS

Three dome lights are mounted on wall directly above mirror. Center light is connected to coach marker light circuit and is illuminated whenever marker lights are on. Refer to "Corner Marker Lights" earlier in this section for continuity. With door locked, circuit through lavatory door switch is energized, and two outer lights are illuminated. This circuit is protected by No. 1 circuit breaker on apparatus panel at left of driver. Bulb(s) is accessible after removing two screws attaching lens to housing.

SIGN LIGHTS

Rest room occupied sign lights, located on transverse partition of compartment are controlled by "ENGINE" switch on driver's instrument panel. With lavatory door locked, circuit through lavatory door switch is energized. This circuit is protected by No. 1 circuit breaker on apparatus panel at left of driver. Bulb(s) is accessible after removing two screws attaching retainer plate to partition.

LIGHT BULB DATA

Name	Qty.	Candlepower or Watts	Trade No.
Headlight Sealed-Beam Unit			
(Inside—Stamped No. 1)	2	37.5W	4001
(Outside—Stamped No. 2)	2	37.5-55W	4002
Instrument Panel Lights	4	7	1445
Speedometer Lamp	1	2	57
Tell-tale Lights	10	7	1445
Rear License Plate Lights	2	6	89
Corner Marker Lights	4	6	89
Michigan Marker Lights	6	4	67
Front Destination Sign Lights	4	15	93
*Side Destination Sign Lights	2	15	93
*Seat Lights	AR	2	57
Entrance Door Step Light	1	21	1141
Taillights	2	6	89
Baggage Compartment Lights	4	21	1141
Engine Compartment Lights	4	15	93
Driver's Light	1	15	93
Night Light	3	2	57
Front Turn Signal Lights	2	32	1073
Rear Turn Signal	2	32	1073
*Side Turn Signal	2	32	1073
Rear Stop Lights	2	32	1073
Reading Lights	40	15	93
General Lights	20	15	93
Freon Receiver Tank Light	1	15	93
*Lavatory Lights	3	15	93
*Lavatory Occupied Sign Lights	2	21	1141
Watch Step Sign Light	2	4	214

(*) Special Equipment

NOTE

All Wiring Diagrams are Located in Back of This Manual.

When Making Electrical Connections, Always Refer to Wiring Diagrams to Make Sure of Proper Connections.

Keep All Connections Clean and Tight. A Clean and Tight Connection is a Good Connection.

The Batteries Are The Heart of The Electrical System; They must be serviced at regular intervals to assure trouble-free operation of all electrical units.

Air Suspension

Information in this section covers complete description, operation, and maintenance of the air suspension system. Replacement of the various air suspension components is also covered. Since replacement of the front and the rear axle consists primarily of disconnecting and connecting the air suspension components, these procedures are also included in this section.

SYSTEM DESCRIPTION

The air suspension system, for the most part, is made up of suspension supports, air bellows, height control valves, radius rods, and shock absorbers. The supports provide the means by which the suspension system is connected to the axles. The system operates automatically and maintains a constant ride height regardless of load or of load distribution.

Vertical loads are supported by eight rubberized nylon fabric air bellows assemblies (fig. 2). Four 9" bellows are used at front axle and four 10" bellows are used at rear axle. Bellows are installed between beams in coach body structure and suspension supports attached to axles as shown in figure 1. Upper bead of bellows is clamped between upper retainer and mounting surface. Lower bead is clamped between lower retainer and piston. When bellows assembly is installed, beads form air-tight seals.

The pressure in air bellows is varied automatically in proportion to vehicle load by height control valves. Three height control valves, one at front axle and two at rear axle, maintain constant vehicle height for all load conditions. Height control valve levers are connected to axles by links.

Radius rods, four at each axle, transmit driving and braking forces from axles to the coach body. These rods also control the lateral and longitudinal position of each axle under the vehicle. Each end of radius rods contains a rubber bushing that requires no lubrication. Telescoping type double-acting shock absorbers are mounted at ends of each axle. Stabilizer bar, attached in rubber mountings to body, is linked at both ends to rear suspension supports.

Suspension supports at front and rear axles are welded steel assemblies. The front suspension supports include bellows lower mounting plates; a bracket is welded to the right front support for the upper and lateral front axle radius rods. Rear suspension supports include mounting pins for lower radius rods, bellows, stabilizer bar links, brake chambers, and height control valve links. Suspension support is bolted to axle bracket.

SYSTEM OPERATION

Compressed air from the front air tank is supplied to height control valves. Pressure regulator valve, however, allows removal of air from front tank only when pressure is above 65 psi. The pressure regulator valve also acts as a check valve which prevents loss of air from the suspension system back into main system. Height control valves, one at front axle and two at rear axle, meter air into the bellows as needed. Valves are actuated by the relative movement between body and axles.

Loading. As coach is loading, the body settles toward axles. This movement operates height control valves and valves meter air into bellows. Air pressure in bellows increases sufficiently to compensate for the additional load. This keeps the coach body at normal ride height.

Unloading. As the coach is unloading, the height control valves exhaust air from the bellows. Valves reduce air pressure in proportion to the decrease in weight, again keeping the coach body at normal ride height.

The height control valves are designed to operate only when load on coach is increased or decreased. Valves do not respond to rapid relative motion between axles and body such as that caused by road bumps. Refer to "Height Control Valves" later in this section for a detailed description of height control valve operation.

SYSTEM MAINTENANCE

Air suspension system requires no lubrication, and with the exception of the inspection and test procedures outlined below, requires very little

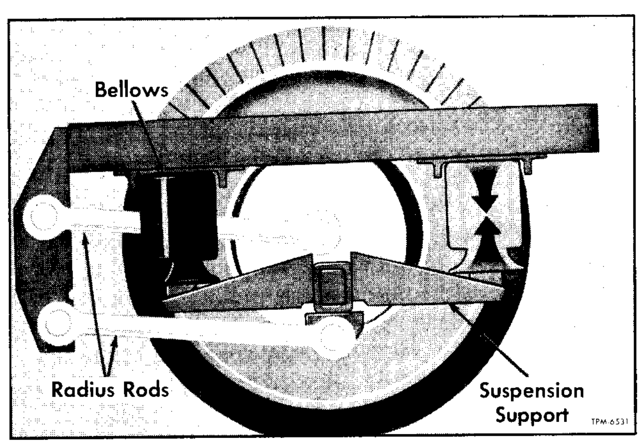


Figure 1—Sketch of Air Suspension System

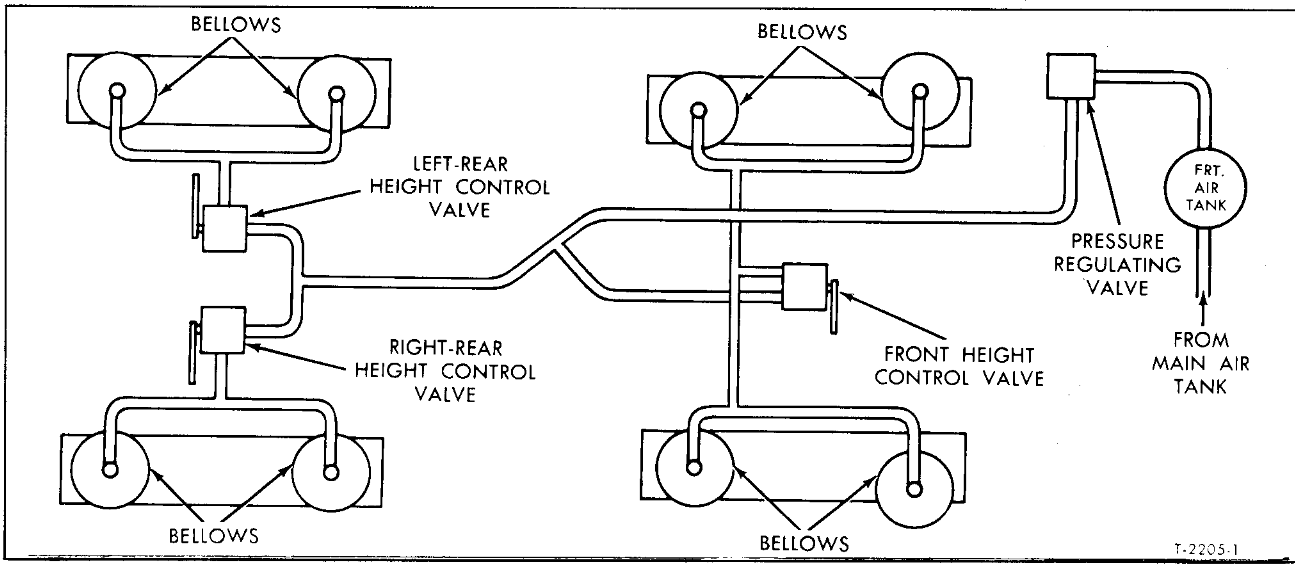


Figure 2—Schematic Diagram of Air Suspension System

maintenance. By accomplishing these inspection and test procedures at established chassis inspection periods, sub-standard performance may be revealed before the condition becomes bad enough to cause operator complaints or failure on a run. Diagram of the suspension air system is schematically shown in figure 2.

CAUTIONS

1. Do not attempt to work under vehicle without first blocking body or placing vehicle over a pit. With air bellows deflated, there is not sufficient clearance under vehicle for a man on a creeper. When blocking body, place blocks under engine cradle forward mounting brackets, also at front end of front axle forward radius rods.
2. Use no lubricant, not even water, on radius rod rubber bushings.
3. If necessary to tow vehicle with one end raised, axle must be chained to body. This is necessary since air pressure will be exhausted from bellows at the raised end. The weight of the axle hanging on the deflated bellows may damage bellows or shock absorbers. Chains can be secured around axle and through the axle bumper brackets.

AIR TANKS

Air tanks must be drained daily to keep air system as free of moisture as possible. In cases of extreme cold weather, an alcohol evaporator should be installed to introduce alcohol vapor into the air system to prevent moisture from freezing. Drain cock is located at bottom of each tank.

AIR LEAKAGE TEST

With the main air system at normal operating pressure (100-120 psi), coat all suspension air line connections and bellows mountings with soap and water solution. Air leakage will produce soap bubbles. No leakage is permissible. Leakage at air line connections can sometimes be stopped by tightening the connection. Where air line connections having rubber sleeves are used, replace rubber sleeve. If tightening mounting nuts does not stop leakage, remove and inspect bellows. Replace bellows, if necessary.

MOUNTING AND BELLOWS INSPECTION

Make a wrench check for loose suspension support stud and mounting bolt nuts, radius rod anchor bolts and nuts, shock absorber mountings, and height control valve mountings. Suspension support, radius rod, and shock absorber mountings must be tightened to torque listed in "Specifications" at end of this section. Visually inspect all bellows for cracks, abrasions, or other damage which might develop into a rupture. Replace with new bellows if any damage is evident. Piston surface should be smooth and free from cracks.

RIDE HEIGHT CHECK AND ADJUSTMENT

Normal system minimum pressure is 105 psi and maximum pressure is 115-120 psi. At this pressure, height control valves will automatically meter air into or out of bellows as load changes.

Normal Ride Height

Ride height measurements are taken between axle bumpers and top of axle housing as shown in figure 3.

NOTE: Normal ride height clearance dimensions given are based on the thickness of new axle

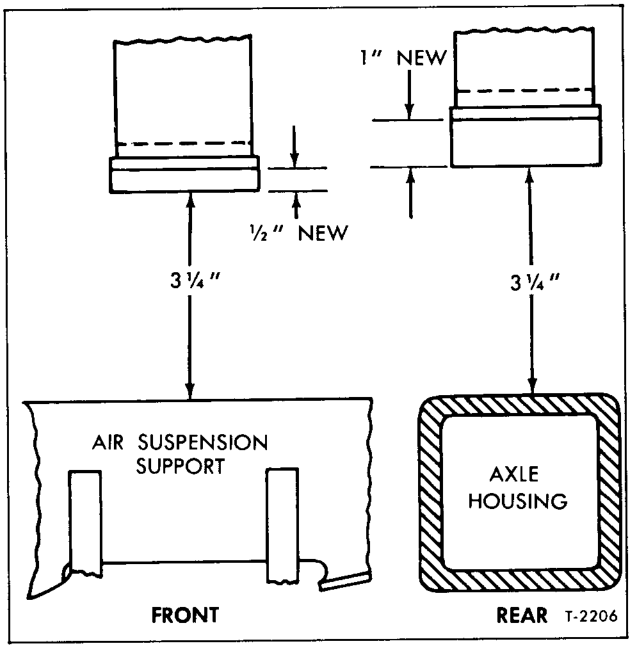


Figure 3—Normal Ride Height Clearance

bumpers (fig. 3). If coach is left standing for extended periods without air pressure in the air suspension system, the weight of the body on the axle bumpers may cause the bumpers to take permanent set in a flattened condition. Original thickness of new bumpers is shown in figure 3. If bumpers are flattened to less than the dimension shown, an equal amount should be added to the clearance specified to maintain normal ride height.

Overtravel Lever Adjustment

Change position of valve lever on overtravel assembly, if necessary, to obtain the above dimensions. Position of the lever may be changed by loosening nut (fig. 4) on adjusting bolt. Intake and exhaust valves of height control valve can then be operated independently of linkage.

Height control valve lever will move 3/16 inch up or down from neutral position (free travel) without causing any valve action. If amount of adjustment required falls within these limits, adjust lever the required amount and tighten adjusting nut to torque listed in "Specifications." However, body will not raise or lower until load is increased or decreased to actuate height control valve.

If any one of the height control valves does not function properly with the lever correctly adjusted, check for restricted air lines. If valve still does not hold body at normal ride height with lever properly adjusted, and with no restriction in air line, valve should be removed and overhauled or replaced with a new or rebuilt unit. Refer to "Height Control Valve Overhaul" later in this section.

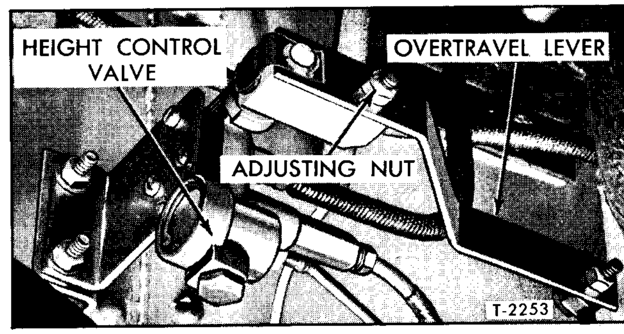


Figure 4—Valve Overtravel Lever Adjustment

FRONT AXLE AND FRONT SUSPENSION REMOVAL

The procedures which follow cover removal of front axle assembly and suspension components. Procedures also cover removal of suspension components from axle assembly. Method used to support axle and suspension units during removal and disassembly depends upon local conditions and available equipment. Front axle and air suspension components are shown in figure 5.

REMOVAL PROCEDURE

1. Block rear wheels to prevent coach from rolling. Position a hydraulic floor jack under each lower radius rod at axle.

CAUTION: Blocks or special adapters should be used on jack lifts in a manner which will prevent axle from rolling off jacks when disconnected.

2. Raise front end of vehicle with jacks until bottom of body is approximately 18" from floor. Block body in raised position. Place each block under bracket at forward end of radius rods.

IMPORTANT: Do not raise body with hoist or chain fall and permit axle to hang unsupported. The weight of the hanging axle may damage the bellows.

3. Lower jacks until body rests on blocks, but with jacks still supporting axle. Remove wheels and tires. Carefully swing ends of jacks out from under vehicle to provide free working area.

4. Exhaust compressed air from air supply system by opening drain cock in suspension air tank.

5. Disconnect hoses from brake chambers, and air lines from bellows.

6. Disconnect height control valve link from bracket attached to steering gear support. Pull down on height control valve lever to exhaust compressed air from bellows.

7. Remove nut from stud attaching bellows lower retainer at each end of two supports.

8. Disconnect steering gear drive shaft rear universal joint from steering gear referring to STEERING SYSTEM (SEC. 16).

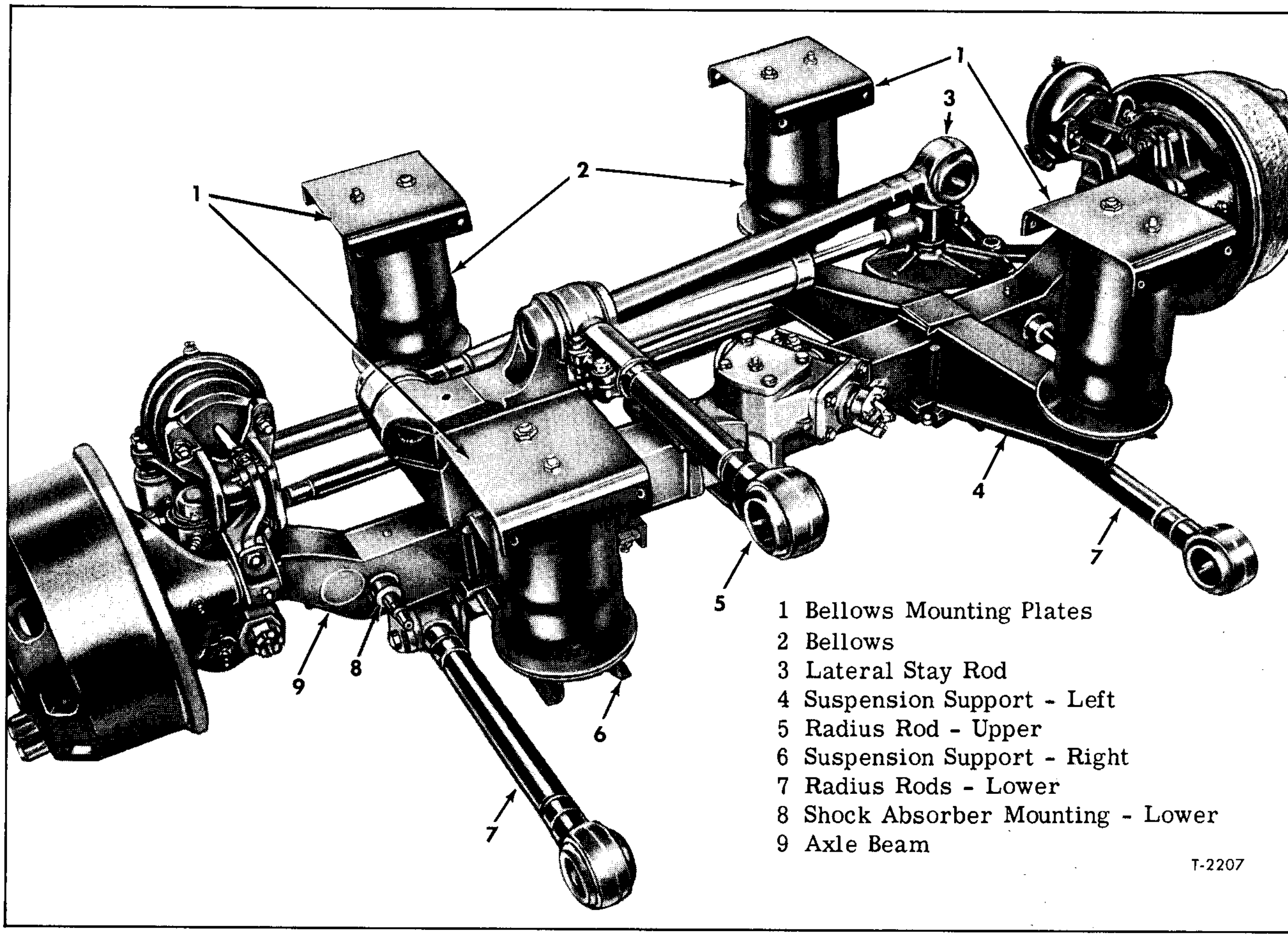


Figure 5—Front Axle and Suspension Units

9. Disconnect both ends of lower radius rods and upper and lateral radius rods. Refer to "Radius Rods" later in this section.

10. Remove shock absorbers as directed in "Shock Absorbers" later in this section.

11. Lower axle on jacks until bellows lower retainer is clear of support and axle will clear underside of coach. Carefully pull jacks and axle assembly from under coach.

12. If desired, remove air bellows as directed in this section under heading "Air Bellows."

REMOVAL OF SUSPENSION COMPONENTS

1. Support axle so that suspension support stud nuts are accessible, then remove nuts.

2. Remove nuts from U-bolt attaching right suspension support to axle beam. Lift suspension supports from axle.

FRONT AXLE AND FRONT SUSPENSION INSTALLATION

Assemble suspension units to axle as illustrated in figure 5, before moving axle under coach. The method used to support axle and suspension supports is dependent upon local conditions and available equipment.

1. Install each suspension support on axle with hole in support over locating pin in axle. Supports are not interchangeable.

2. Install brackets under axle beam and over support studs. Bracket should fit over locating pin and with radius rod anchor pin toward outside. Install washers and nuts and tighten to torque listed in "Specifications" at end of this section.

3. Install U-bolt clamp over right suspension support through U-bolt support on axle. Install washers and nuts and tighten to torque listed in "Specifications."

4. Place upper and lateral radius rods in position over locating pins on support. Lateral radius rod anchor pin on support will be at rear of axle and on right side.

INSTALLATION PROCEDURE

1. If bellows assemblies have been removed, they should be installed on coach before axle is moved back under coach. Refer to bellows install-

ation under "Air Bellows" heading in this section for installation procedure.

2. Position axle on two hydraulic floor jacks, with one jack lift under each lower radius rod axle bracket.

CAUTION: Blocks or special adapters should be used on jack lifts to prevent axle from falling.

3. Carefully move axle into position under coach. Lift axle and align bellows lower retainer bolt with support plate. Install bolt nut, and washer and tighten to torque listed in "Specifications."

4. Connect upper radius rod and lateral radius rod to anchor brackets. Refer to "Radius Rods" later in this section. Do not tighten cap screws or mounting bolt nut.

5. Install lower radius rods. Refer to "Radius Rods" later in this section. Do not tighten cap screws or mounting bolt nuts.

6. Install shock absorbers as directed under "Shock Absorbers" later in this section.

7. Position each end of axle by raising or lowering jacks to provide a clearance of 3-1/4" (normal ride height) between axle bumper and contact surface on suspension support (fig. 3). Refer to "Normal Ride Height" in "Ride Height Check and Adjustment" earlier in this section. With axle in normal ride height position, tighten radius rod cap screws and anchor bolt lock nuts to torque listed in "Specifications."

8. With axle still in normal ride height position (step 7 above), connect height control valve link to height control valve. Tighten nut to torque listed in "Specifications."

9. Connect steering gear drive shaft to steering gear, referring to STEERING SYSTEM (SEC. 16).

10. Connect flexible hoses to each brake chamber. Make sure connections are tight, properly aligning hose to eliminate any twist or possible chafing when axles move through travel. Connect air lines to bellows. Replace rubber sleeves if deteriorated or damaged.

11. Swing jacks under the vehicle to permit installation of wheels. Install wheels. Refer to "WHEELS AND TIRES" (SEC. 19).

12. Raise coach and remove blocks from under body. Lower vehicle to floor and remove jacks. Build up air pressure in system to normal operating pressure. Wait a few minutes for air to flow into suspension system, then check clearance between axle bumpers and suspension supports (fig. 3). If clearance is 1/8" more or less than 3-1/4" adjust overtravel lever on height control valve as necessary to obtain this dimension. Refer to "Ride Height Check and Adjustment" earlier in this section. Make sure lever adjusting screw is tight when adjustment is completed.

13. Check for air leakage at all bellows upper and lower mountings. Coat mountings with soap and water solution and watch for appearance of soap bubbles. No leakage is permissible. If leakage is evident, bellows must be disconnected and mating surfaces must be cleaned. Bellows must be replaced if bead is damaged.

REAR AXLE AND REAR SUSPENSION REMOVAL

The procedures which follow cover removal of rear axle assembly and suspension components. Procedures also cover removal of suspension components from axle assembly. Method used to support axle and suspension units during removal and disassembly depends upon local conditions and available equipment. Rear axle and air suspension units are shown in figure 6.

REMOVAL PROCEDURE

1. Block front wheels to prevent coach from rolling. Position a hydraulic floor jack under center of each suspension support.

CAUTION: Jack lifts should be equipped with large bowls, or similar precautions should be taken to prevent axle from rolling off jacks when disconnected.

2. Raise rear end of vehicle with jacks until bottom of body is approximately 18" from floor. Block body in raised position. Make sure blocks are placed under engine cradle forward mounting brackets.

IMPORTANT: Do not raise body with hoist or chain fall and permit axle to hang unsupported. The weight of the axle will damage the bellows.

3. Lower jacks until body rests on blocks, but with jacks still supporting axle. Remove wheels and tires. Carefully swing jacks out from under vehicle to provide free working area.

4. Exhaust compressed air from air supply system by opening drain cock in suspension air tank.

5. Disconnect flexible hoses from brake chambers, and air lines from bellows.

6. Disconnect height control valve links from overtravel levers. Pull down on each height control valve lever to exhaust compressed air from bellows.

7. Disconnect propeller shaft, referring to PROPELLER SHAFT (SEC. 18).

8. Disconnect stabilizer bar. Refer to "Stabilizer Bar" later in this section.

9. Remove upper and lower radius rods. Refer to "Radius Rods" later in this section.

10. Remove nuts and washers attaching each bellows lower retainer to support plate.

11. Remove shock absorbers as directed under "Shock Absorbers" later in this section.

12. Lower axle on jacks until assembly will clear underside of vehicle. Carefully pull jacks and axle assembly from under vehicle.

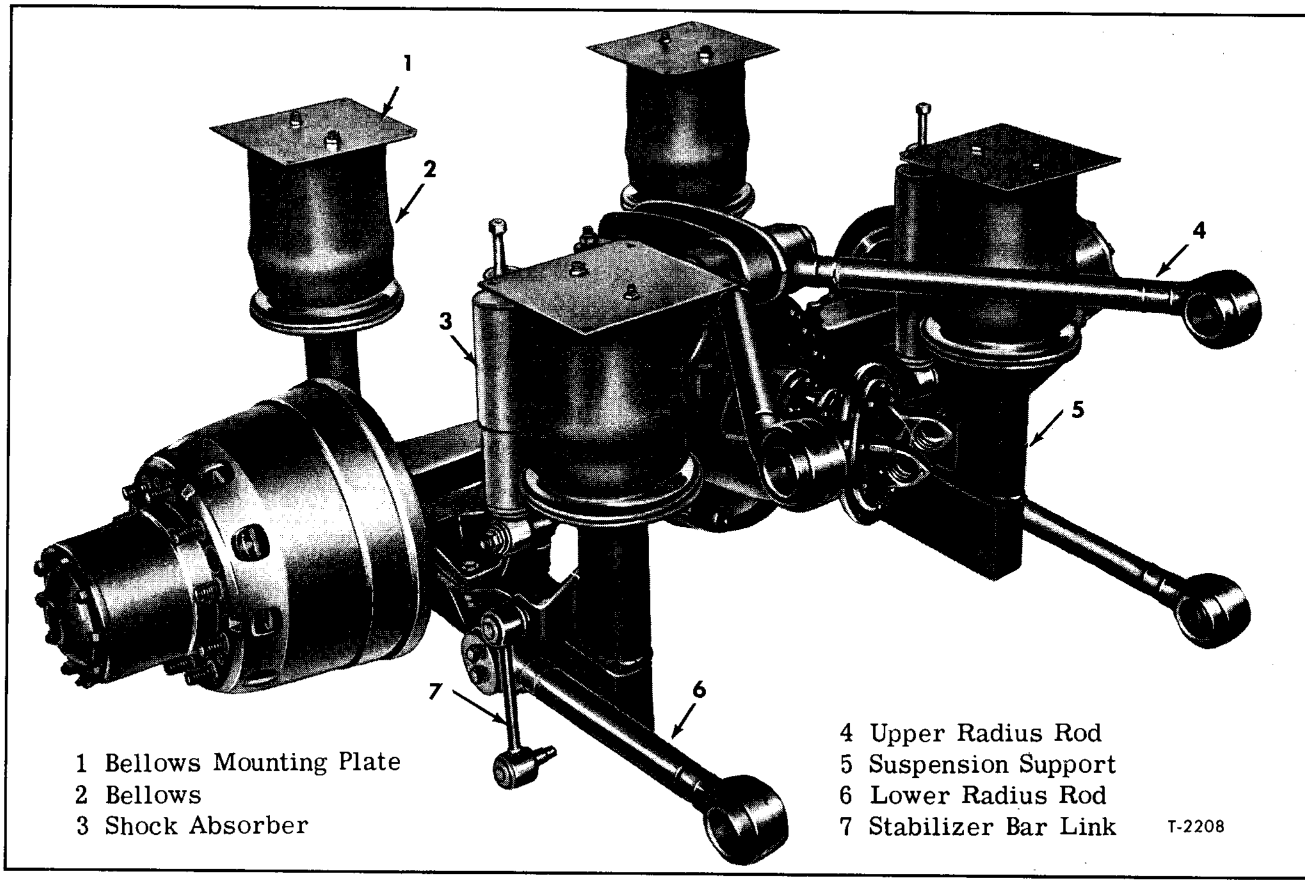


Figure 6—Rear Axle and Suspension Components

13. If desired, remove bellows as directed in this section under heading "Air Bellows."

REMOVAL OF SUSPENSION SUPPORTS

1. Support axle assembly so that suspension supports may be removed safely from axle.
2. Remove brake chambers and stabilizer bar links from suspension supports.
3. Remove four nuts, spacers, and bolts attaching each suspension support to axle housing. Remove suspension support.

REAR AXLE AND REAR SUSPENSION INSTALLATION

ASSEMBLY OF AXLE AND SUSPENSION SUPPORTS

Assemble suspension units to axle before moving axle under coach as illustrated in figure 6. Radius rods, however, should be installed after axle is in position. The method used to support axle and suspension supports is dependent upon local conditions and available equipment. Tighten all studs, bolts, and nuts to torque listed in "Specifications."

1. Position each suspension support under axle. Radius rod and shock absorber anchor pins on supports should be on rear side of the axle. Attach support to axle with four bolts, spacers, and nuts. Tighten nuts to torque listed in "Specifications."
2. Attach brake chambers and stabilizer bar links.

INSTALLATION PROCEDURE

1. If bellows assemblies have been removed, they should be installed on supports before axle is moved under coach. Refer to bellows installation under "Air Bellows" heading in this section for installation procedure.
2. Center a hydraulic floor jack under each suspension support.

CAUTION: Jack lifts should be equipped with large bowls, or similar precautions should be taken to prevent axle from rolling off jacks when disconnected.

3. Carefully move jacks and axle assembly into position under coach. Lift axle and align plate on each bellows assembly with plate on beams. Attach each bellows mounting plate to beam with four bolts. Tighten nuts to torque listed in "Specs."
4. Install shock absorbers as directed under

"Shock Absorbers" later in this section.

5. Connect upper and lower radius rods. Refer to "Radius Rods" later in this section. Do not tighten cap screws or lock nuts.

6. Raise or lower jacks to provide an axle clearance of 3-1/4" (normal ride height) between rubber axle bumpers and axle as shown in figure 3. Refer to "Ride Height Check and Adjustment" earlier in this section. With axle in normal ride height position, tighten radius rod cap screws and anchor bolt lock nuts to torque listed in "Specifications" at end of this section.

7. With axle still in normal ride height position (step 6 above), connect height control valve links to valves.

8. Connect propeller shaft to axle, referring to PROPELLER SHAFT (SEC. 18).

9. Connect flexible hose to brake chambers. Make sure connections are tight, properly aligning hose to eliminate any twist or possible chafing when axles move through travel. Connect air lines to bellows. Replace rubber sleeves if deteriorated or damaged.

10. Install stabilizer bar and links as directed under "Stabilizer Bar" later in this section.

11. Swing jack out of the way under coach and install wheels. Refer to "WHEELS AND TIRES" (SEC. 19).

12. Raise coach with jacks and remove blocks from under body. Lower vehicle to floor and remove jacks. Build up air pressure in system to normal operating pressure. Wait a few minutes for air to flow into bellows, then check clearance between axle bumpers and axle (fig. 3). If clearance is 1/8 inch more or less than 3-1/4 inch, adjust overtravel lever on each height control valve as necessary to obtain this dimension. Refer to "Ride Height Check and Adjustment" earlier in this section. Make sure lever adjusting screw is tight when adjustment is completed.

13. Check for air leakage at all bellows upper and lower mountings. Coat mountings with soap and water solution and watch for appearance of soap bubbles. No leakage is permissible. If leakage is evident, bellows must be disconnected and mating surfaces must be cleaned. Bellows must be replaced if bead is damaged.

RADIUS RODS

All radius rods, and lateral stay rod used at front axle, are hollow steel tubes with steel forgings welded to each end. Rear axle upper radius rods are interchangeable with each other (front axle and rear axle lower radius rods are all interchangeable). The front upper radius rod is two-piece and threaded into a clamp and locked by two bolts, therefore an adjustment for front axle caster is provided. All front and rear radius rod bushings, anchor plates, and anchor plate spacers are interchangeable.

Radius rod connections at axle and at body are illustrated in figure 8. While anchor pin installations and body brackets at various points differ from the ones shown, attaching parts are identical at all points. Lateral stay rod and upper radius rod at front end is connected at axle and at body bracket in same manner as shown in figure 8 for radius rod connection at axles. Follow procedure for axle mounting to remove or install upper and lateral rods at body.

RADIUS ROD REPLACEMENT (Fig. 8)

The following procedures include instructions for disconnecting and connecting radius rods at body and at axles. Radius rods must be disconnected at body before axle end can be removed from anchor pin. Instructions applying to radius rod connections at axle also apply to the front axle lateral stay and upper radius rods. Raise body just enough to remove weight from air bellows and block in position before disconnecting radius rods or front axle lateral stay rod.

IMPORTANT: When any radius rod or the lateral stay rod has been disconnected, correct height control clearance between axle bumpers and axles must be obtained before tightening anchor pin cap screws or anchor plate bolts. If connections are tightened without first obtaining this clearance, a torsional preload will be imposed on the rubber bushings when the body assumes its normal ride height relative to the axles. Instructions under "Tighten Cap Screws and Bolt Nuts" must be followed explicitly.

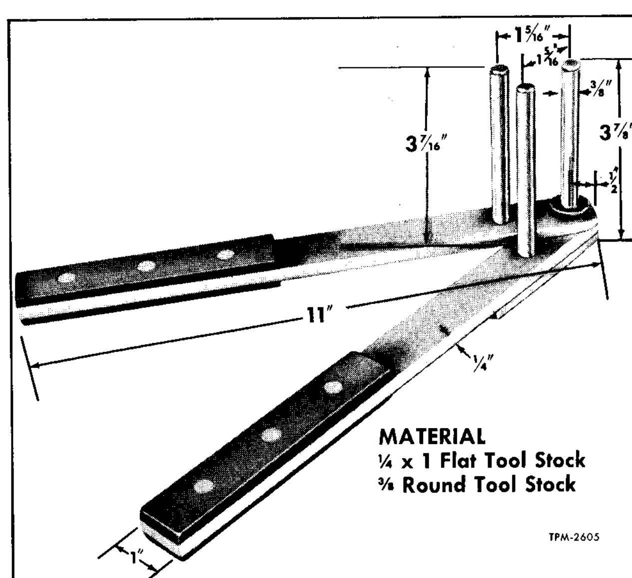


Figure 7—Radius Rod Bushing Installer Tool

RADIUS ROD BUSHING REPLACEMENT

A special tool (fig. 7) which can be made locally, is effective when removing or installing one-piece rubber bushing in radius rod. Use of tool is illustrated in figure 9. Position bushing over tool as shown, then swing tool arms in direction of arrows to fold the bushing. With bushing folded on tool it can be easily removed or installed. Swing arms in opposite direction to unfold bushing and withdraw tool.

Remove Radius Rod at Body

Remove nuts from four anchor plate bolts, then remove bolts and anchor plates.

NOTE: Access to rear ends of rear axle upper radius rods is from under vehicle through opening between bulkhead at rear of wheelhousings and engine bulkhead.

Remove Radius Rod at Axle

Remove cap screws and anchor pin washer. Pull radius rod and bushings off anchor pins.

Inspection

Inspect radius rods for bent condition and for cracks. Any damage necessitates replacing with new part. Always use new rubber bushings at assembly. Thoroughly clean rod ends, anchor plate spacers, anchor pins, and anchor plates; any surface contacting rubber bushings must be clean,

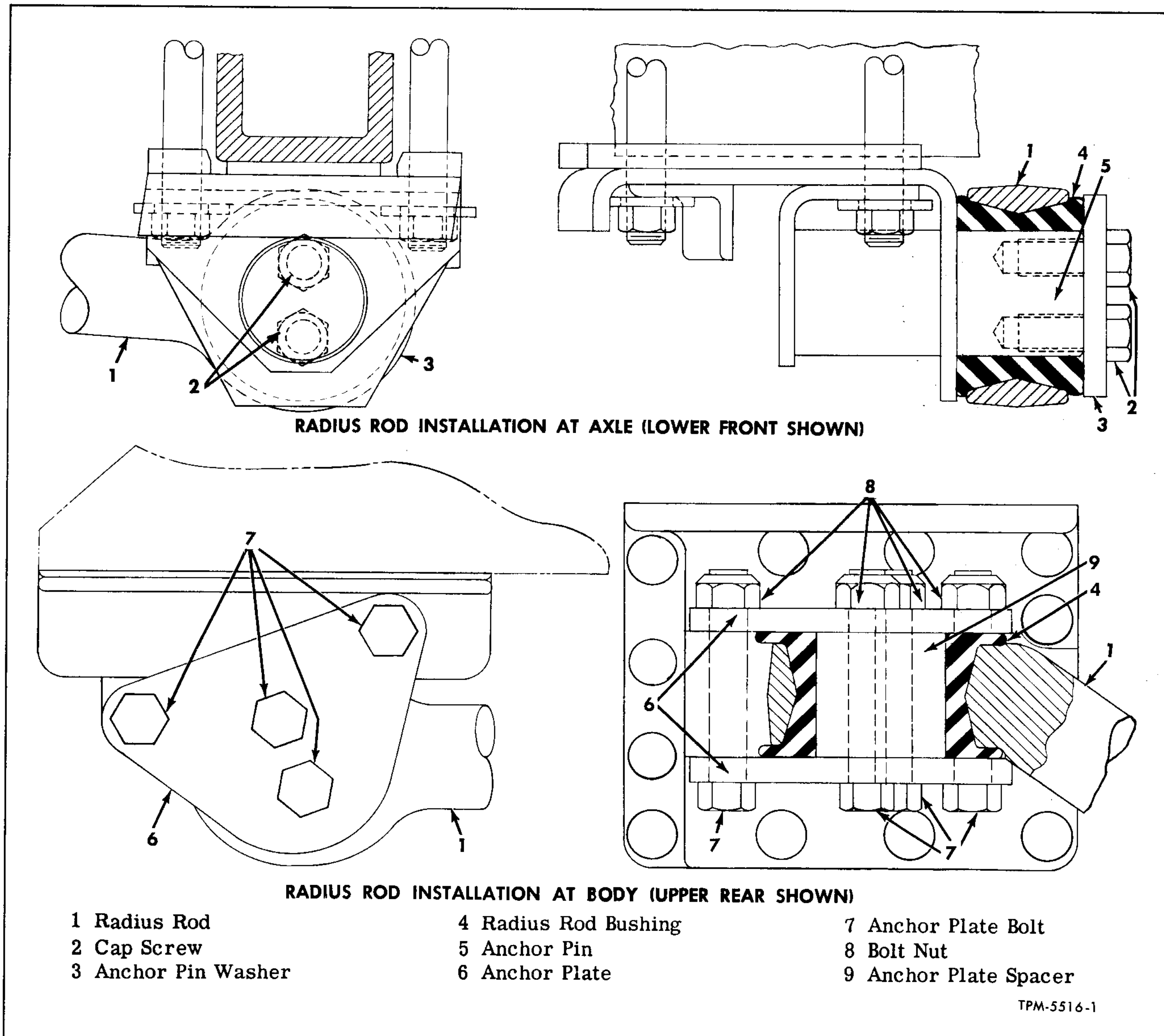


Figure 8—Radius Rod End Mountings

smooth, and dry. USE NO LUBRICANT (NOT EVEN WATER) ON BUSHINGS.

Install Radius Rod at Axle

Install anchor pin washer. Install two cap screws but do not tighten.

Install Radius Rod at Body

1. Install anchor plate spacer in radius rod end.

2. Temporarily insert a 3/4 x 5-inch bolt through center hole in one anchor plate, insert bolt through upper hole in anchor plate spacer, then place other anchor plate over bolt. Install nut on bolt and tighten finger-tight.

3. Align other holes in anchor plates with holes in bracket and spacer and insert three permanent 3/4 x 4-1/4-inch bolts. Coat threads with No. 110 Lubriplate. Tighten nut on temporary bolt to draw anchor plates together, compressing rubber bushings, until nuts can be started on the other three bolts. Start nuts on bolts, remove temporary bolt, and install permanent bolt and nut.

Tighten Cap Screws and Bolt Nuts

1. Refer to "Installation Procedure" under "Front Axle and Air Suspension Installation" or "Rear Axle and Air Suspension Installation" for instructions on obtaining normal ride height clearance between axle bumpers and axles.

2. At body, alternately tighten each nut a little at a time to keep spacer centered in bushing. When tightened correctly space between radius rod and anchor plates will be equal on both sides.

3. At axle, use a pry bar to force radius rod end out toward anchor pin washer (fig. 10) while tightening anchor pin cap screws. Do not pinch

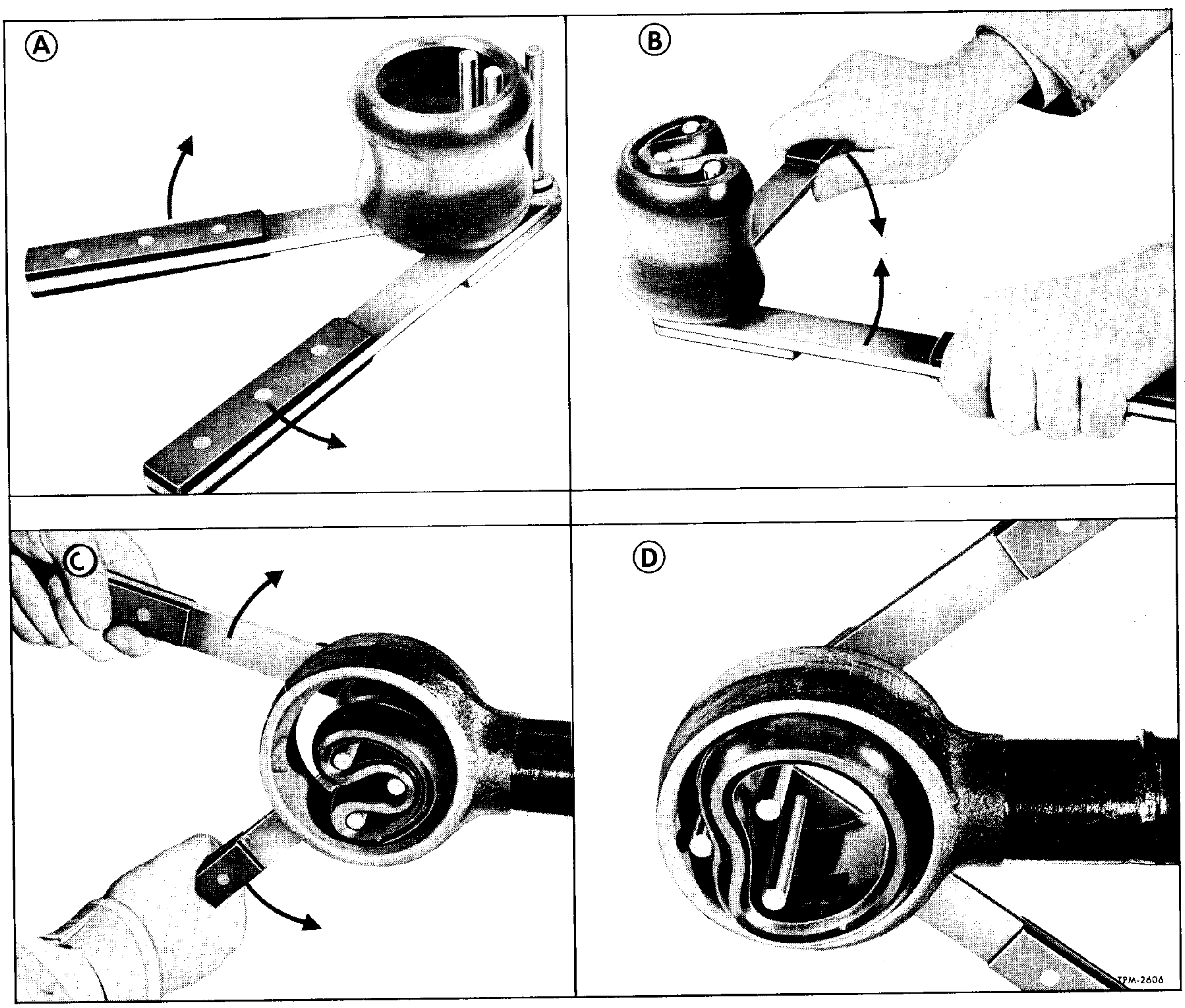


Figure 9—Use of Radius Rod Bushing Installer Tool

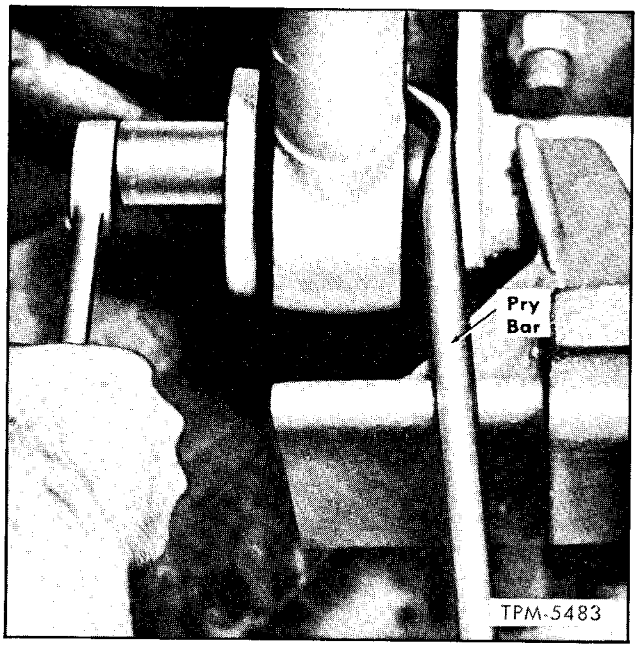


Figure 10—Tightening Radius Rod Cap Screws

edge of bushing with pry bar.

4. Due to inaccessibility of rear axle upper radius rod rear nuts, torque wrench cannot be applied to nuts; tighten nuts until anchor plates are drawn up squarely and tightly against anchor plate bracket and spacer.

STABILIZER BAR

Stabilizer bar (fig. 11) is anchored to lower radius rod anchor plate brackets and to the rear axle to control vehicle stability. Rubber bushed clamps anchor bar firmly to brackets while links at each suspension support connect ends of bar to rear axle. Retainers on the bar are clamped flush against each inner rubber bushing.

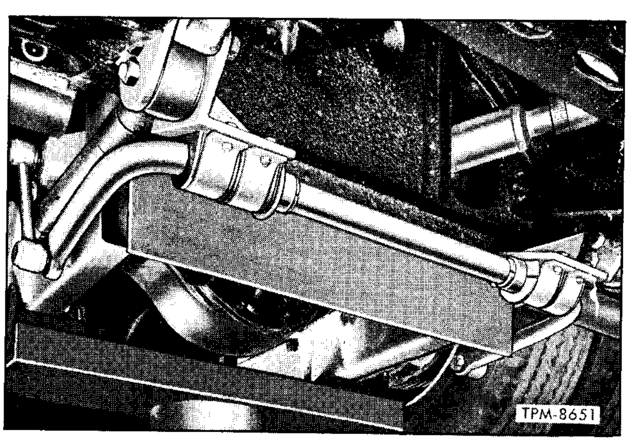


Figure 11—Stabilizer Bar Installed

REPLACEMENT

Removal

1. Remove cotter pins and nuts from link ball studs. Discard cotter pins. Remove both stabilizer bar links.

2. Support bar and remove bolts from bar clamps at each side. Remove clamps, stabilizer bar, and rubber bushings. Loosen clamp nut and move each bushing retainer aside, if necessary.

Installation

1. Space bushings properly and place stabilizer bar in position under coach. While supporting bar, loosely attach a bar clamp around each bushing with bracket bolt nuts.

2. Wipe all grease, oil, or foreign matter from link stud tapers and from tapered holes.

NOTE: To avoid a preload on link stud rubber mountings, install links when vehicle is at normal ride height. Refer to "Ride Height Check and Adjustment" earlier in this section.

3. Install links and secure with nuts. Tighten clamp bolt nuts and link stud nuts to torque listed in "Specifications" at end of this section. Advance each link stud nut to meet cotter pin slot and install new cotter pins.

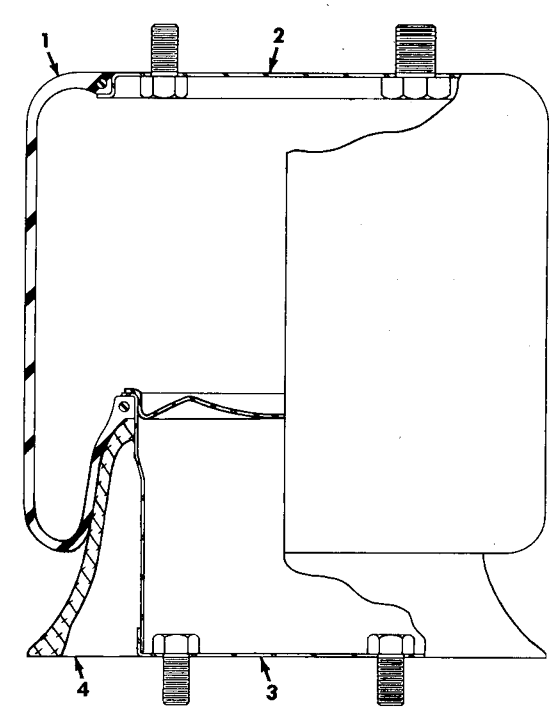


Figure 12—Sectional View of Rear Air Bellows

4. If bushing retainers have been removed, place two halves around bar and against inside of rubber bushing. Slip retainer clamp over assembly and tighten nut to torque listed in "Specifications" at end of this section.

AIR BELLOWS

Four "rolling lobe" type bellows made of rubberized nylon fabric are mounted at each axle (figs. 5 and 6). These "air cushions" provide the flexibility between axles and coach body. At the same time, the bellows retain the compressed air which supports the body. Refer to "Specifications" at end of this section for bellows identification and size.

The square bead at each end of bellows is reinforced with wire. The opening at piston end (bottom) is smaller than opening at top. Bottom bead is clamped between lower retainer and upper edge of piston as shown in figures 12, and 13. When bellows is inflated, beads form air-tight seals. In operation, the bellows folds down over piston, taking a lobe-shaped contour. One of the studs in upper retainer is drilled and threaded for an air line connection.

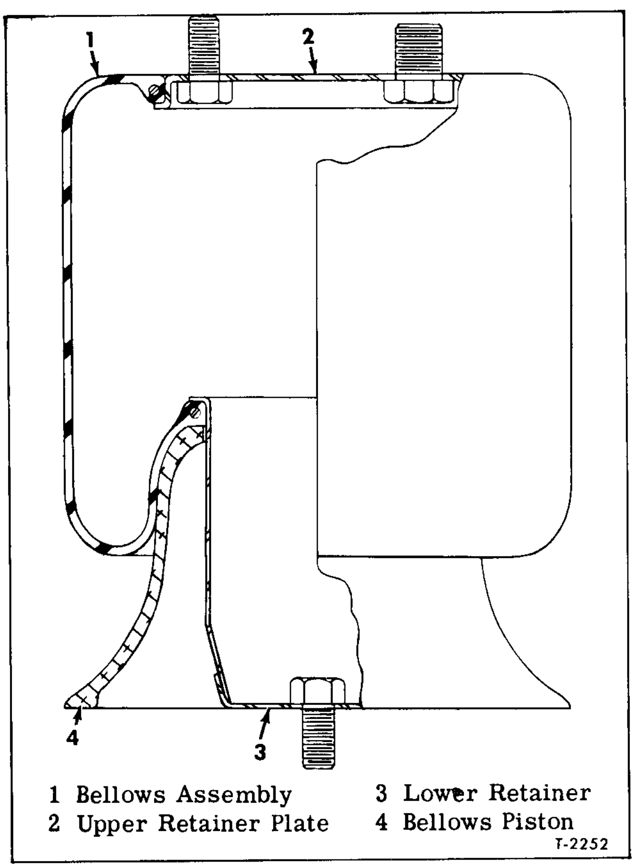


Figure 13—Sectional View of Front Air Bellows

REMOVAL

1. Securely support coach body by placing blocks under body at points indicated for respective axle and suspension removal procedure.

2. If system is pressurized, disconnect height control valve link (one at front and two at rear) then pull down height control valve overtravel lever to exhaust air from bellows. Do not change height control valve lever adjustment.

3. Remove four nuts and bolts attaching mounting plate to beam. Remove lock nut from stud at bottom of bellows assembly (one stud on each front bellows, two studs on each rear bellows). Collapse bellows to get clearance, then disconnect air line and remove bellows assembly.

4. Remove nut and lock washer from large stud and remove nut from small stud attaching mounting plate to upper retainer. Remove mounting plate.

DISASSEMBLY

1. With bellows assembly on bench, apply air through hollow fitting in upper retainer (fig. 14) until loop or fold is removed and bellows is straight.

2. Place wood block across upper retainer, then drive with hammer (fig. 15) until retainer is loose from bellows bead.

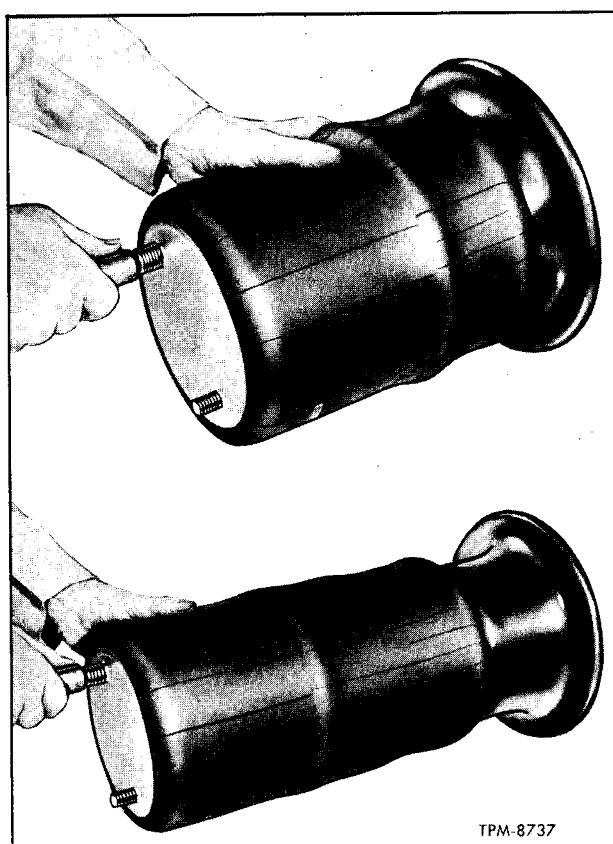


Figure 14—Removing Bellows Loop with Air Pressure

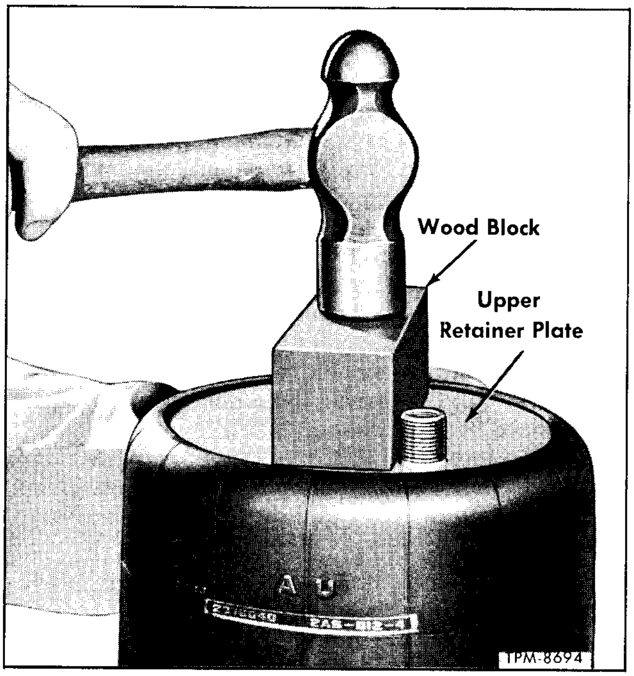


Figure 15—Loosening Retainer Plate from Bellows Bead

3. Press bellows to elongate opening, in order that upper retainer can be removed (fig. 16).

4. In many instances it will be necessary to drive lower retainer out of piston. A locally made driving plate installed over end of retainer will prevent damage to retainer as it is driven from piston, as illustrated in figure 17.

Figure 16—Removing or Installing Upper Retainer Plate

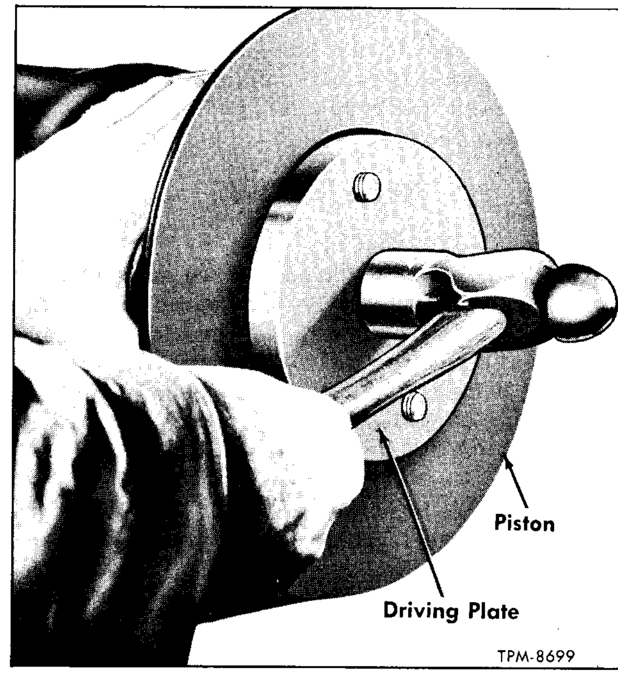


Figure 17—Removing Lower Retainer from Piston

5. Apply liquid soap or glycerine to lower retainer surface at point of bellows contact (fig. 18). Force screwdriver between retainer and bellows bead (fig. 18) to allow fluid to reach bellows bead.

6. When bead is loosened around entire surface of retainer, the retainer can be forced into bellows and removed through upper opening.

INSPECTION

Examine bellows inside and out for evidence of cracks, punctures, deterioration, or chafing.

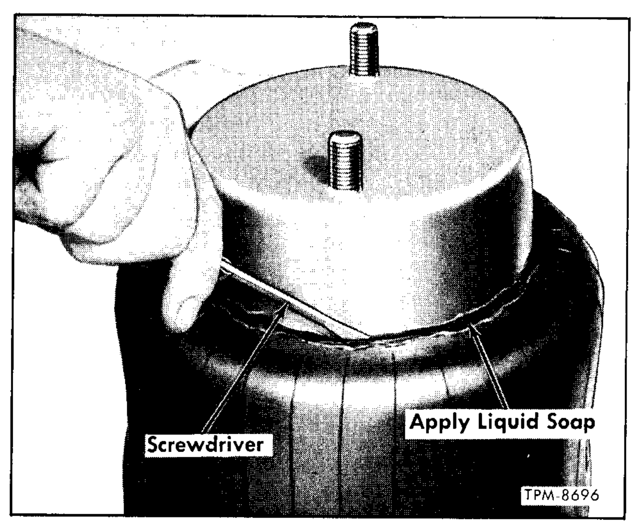


Figure 18—Loosening Bellows Bead from Lower Retainer

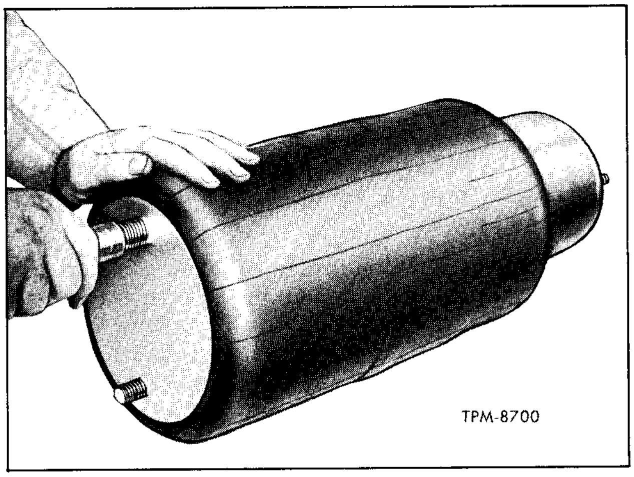


Figure 19—Seating Retainers in Bellows with Air Pressure

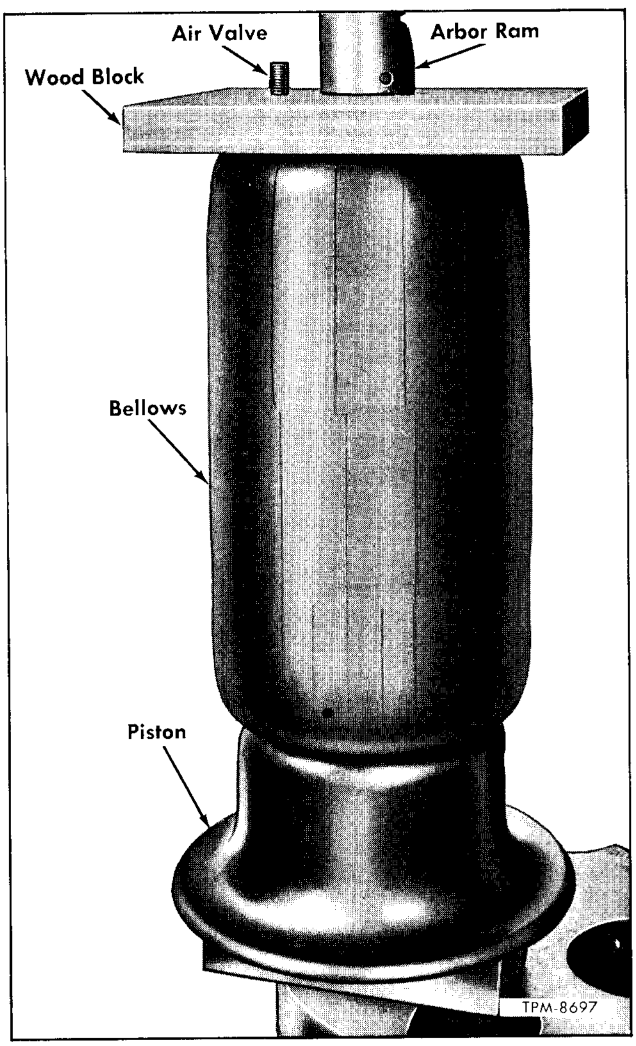


Figure 20—Forming Bellows Loop over Piston Using Arbor Press

Replace with new bellows if any damage is evident. Any surface on upper and lower retainers or on piston that touches bellows should be smooth and free of cracks that might cause breaks or damage bellows. Check threads on studs. Replace any damaged parts.

ASSEMBLY

1. Install lower retainer assembly through bellows upper opening and into lower opening.
2. Install upper retainer in place in bellows, align arrows on bellows with studs in upper retainer. Make sure that studs in rear bellows lower retainer are at right angle to studs in upper retainer.
3. Apply air in bellows through opening in upper retainer stud (fig. 19) to seat lower and upper retainers in bellows.
4. Install piston over lower retainer.
5. Install air supply valve in upper retainer stud, then inflate bellows to 5 pounds pressure.
6. Using block of hard wood (1" x 10"), drill two 1" holes so that block will fit over two studs in upper retainer.
7. Install bellows assembly in arbor press (fig. 20) with two studs in lower retainer astride a block so that assembly will rest against retainer and piston.

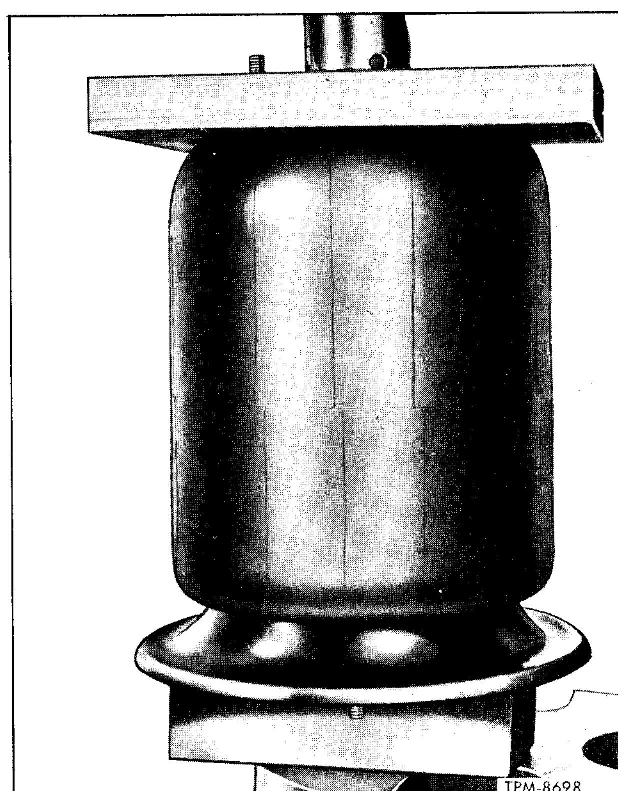


Figure 21—Bellows Loop Rolled over Piston

NOTE: For front bellows where only one lower retainer stud exists, place one block on each side of stud.

8. Install locally made block over top of bellows assembly with upper retainer studs through holes in block (fig. 20).

9. Operate arbor press to compress air and cause lower end of bellows to fold over piston. Continue to press until a dimension of approximately 12" overall height is obtained (fig. 21).

WARNING: Before releasing arbor press be sure that air is released from bellows by opening air valve.

10. Remove assembly from arbor press, then remove wood block and air supply valve.

INSTALLATION

1. Place bellows assembly in position between suspension support and beam.

2. Place mounting plate over studs in upper retainer. Edges of plate of front axle should extend downward. Install large nut and lock washer on large stud, and small nut on small stud. Tighten nuts to torque listed in "Specifications."

Front Bellows. The larger of two studs at top of each bellows assembly should be positioned as shown in figure 5. Connect air lines to bellows. Replace rubber sleeves if deteriorated or damaged. Seat mounting plate solidly against beam and attach with four bolts and lock nuts. Insert bolts from bellows side of plate. Install nut on studs at bottom of bellows. Tighten all nuts to torque listed in "Specifications."

Rear Bellows. The larger of two studs at top of each bellows assembly should be toward rear axle. Connect air lines to bellows. Replace rubber sleeves if deteriorated or damaged. Attach mounting plate with four bolts and four lock nuts. Install two lock nuts on studs at bottom of bellows. Tighten all nuts to torque listed in "Specifications" later.

4. Connect height control valve links, if disconnected. Make sure lever adjustment has not been changed.

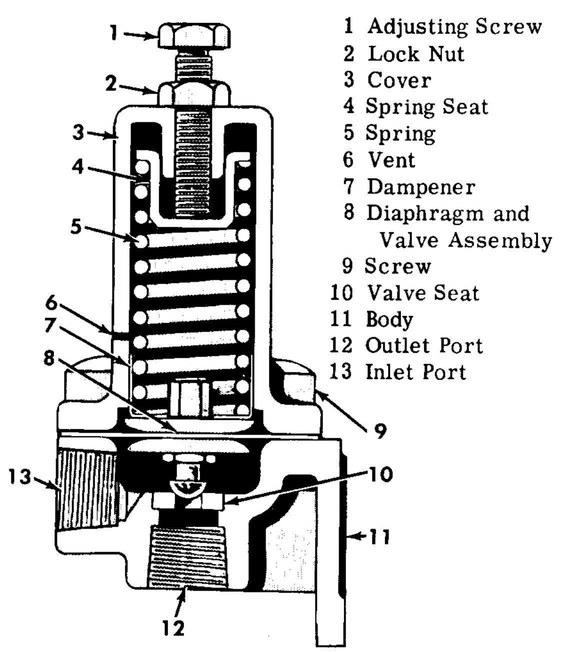
5. Build up air pressure to normal operating pressure. Remove blocks from under coach.

6. Check for air leaks at upper and lower mountings of bellows by coating with solution of soap and water. Any leaks showing up as bubbles must be stopped.

PRESSURE REGULATOR VALVE

DESCRIPTION

Pressure regulator valve (fig. 22) is mounted on the coach body near the front air tank. This valve serves three purposes. One purpose is to prevent entry of compressed air into air suspension system until pressure in air brake system reaches 65 psi. This makes possible a rapid build-up of air pressure for operation of air brakes. When brake system air pressure exceeds 65 psi, the pressure regulator valve opens and allows pressure to build up in suspension system. The second purpose of the valve is to prevent loss of brake system air pressure below 65 psi due to leakage in suspension system. The third purpose of the valve is to act as a check valve for the air suspension system.



1 Adjusting Screw
2 Lock Nut
3 Cover
4 Spring Seat
5 Spring
6 Vent
7 Dampener
8 Diaphragm and Valve Assembly
9 Screw
10 Valve Seat
11 Body
12 Outlet Port
13 Inlet Port

Figure 22—Pressure Regulator Valve

SERVICEABILITY TESTS

OPERATING TEST

1. Exhaust compressed air from air system by opening drain cock at air tank. Close drain cock when tank is empty.

2. Connect a test air pressure gauge, preferably in line leading from air tank to pressure regulator valve.

3. Disconnect air line at bottom of pressure regulator valve.

4. Build up air pressure in system and note pressure on test gauge at instant valve opens and discharges air through open line.

5. Adjust valve if pressure varies 5 psi from the original setting (65 psi). Refer to instructions listed under "Pressure Setting Adjustment."

LEAKAGE TEST

With air line still disconnected at bottom of valve, build up air pressure to a point just below

valve setting (65 psi). Coat opening with soap suds to check for leakage. Also apply soap suds to vent opening in valve cover.

No leakage is permissible at vent opening in valve cover. Leakage at this point indicates a ruptured diaphragm. Replace ruptured diaphragm with new part.

Leakage amounting to a 3-inch bubble in 3 seconds at outlet port is permissible. Excessive leakage is an indication of a dirty or worn valve or valve seat. To clean or replace parts in valve, refer to "Pressure Regulator Valve Overhaul" procedure.

PRESSURE SETTING ADJUSTMENT (Fig. 22)

The adjusting screw (1) controls the pressure at which the valve is unseated. Setting may be increased or decreased by turning screw.

1. Back off lock nut (2). Turn screw clockwise to increase pressure, or counterclockwise to decrease pressure.
2. Tighten lock nut (2) when correct adjustment is obtained.

PRESSURE REGULATOR VALVE OVERHAUL

DISASSEMBLY (Fig. 22)

1. Exhaust compressed air from system by opening drain cock at air tank. Close drain cock when tank is empty.
2. Disconnect air line at inlet port (13).
3. Remove four screws (9) attaching cover (3) to body (11) and remove cover.
4. Remove spring seat (4), spring (5), and damper (7) from cover.
5. Lift diaphragm and valve assembly (8) off body.

CLEANING AND INSPECTION

Clean all parts thoroughly, using a suitable cleaning solvent. Examine diaphragm and valve assembly for cracks or wear. If either the valve or the diaphragm are worn or damaged, a new valve and diaphragm assembly must be installed. Inspect valve seat (10) in body. If seat is pitted, scratched, or chipped, it should be replaced.

ASSEMBLY (Fig. 22)

1. Place diaphragm and valve assembly (8) with valve seated in valve seat (10).
2. Install spring seat (4), spring (5), and damper (7) in cover (3) and position cover on body (11).
3. Install four screws (9) through cover and diaphragm into body and tighten firmly.
4. Connect air line to inlet port (13) and adjust pressure setting as previously directed under "Pressure Setting Adjustment."

HEIGHT CONTROL VALVES

DESCRIPTION

Height control valves automatically maintain a constant vehicle height by controlling the flow of compressed air into or out of suspension system air bellows. Three height control valves are used in each coach air suspension system; one at the front axle and two at the rear suspension supports. A delay piston contained in each valve provides a momentary delay in intake and exhaust valve action; subsequently, air in bellows is supplied or exhausted only during load changes and not during intermittent road bumps. Figure 23 shows front and rear height control valves installed.

Each height control valve contains an intake valve, air bellows outlet, exhaust valve, delay piston, and overtravel control body. The overtravel control body contains a spring-loaded nylon piston which protects valve parts if overtravel lever is moved beyond normal operating range. A check valve is also provided in the air inlet tube of each inlet valve.

The front and right rear height control valves are identical with the exception of the overtravel lever. These valves are interchangeable if the overtravel lever (fig. 23) is changed for specific use. The left rear height control valve is opposite in construction to the right rear; therefore it is not interchangeable with others.

HEIGHT CONTROL VALVE OPERATION

Figure 24 shows cross-section of a valve assembly in the three phases of operation. Valve operation is illustrated as coach is unloaded, at normal ride height, and as coach is loaded. Each valve adjusts independently for the following conditions:

LOADING

When coach is loaded, coach body settles. Since valve is linked to suspension, and valve is bolted to body, valve moves downward with body as body is loaded. As overtravel lever and control shaft turns, a force is applied to the delay piston which moves slowly and allows the intake valve lever to move against the intake valve core. As pin is pushed in, air pressure flows through height control valve into bellows. Increased air pressure expands bellows and raises body.

Inlet valve is "protected" by check valve (see fig. 24) in inlet adapter. Light spring in core freely

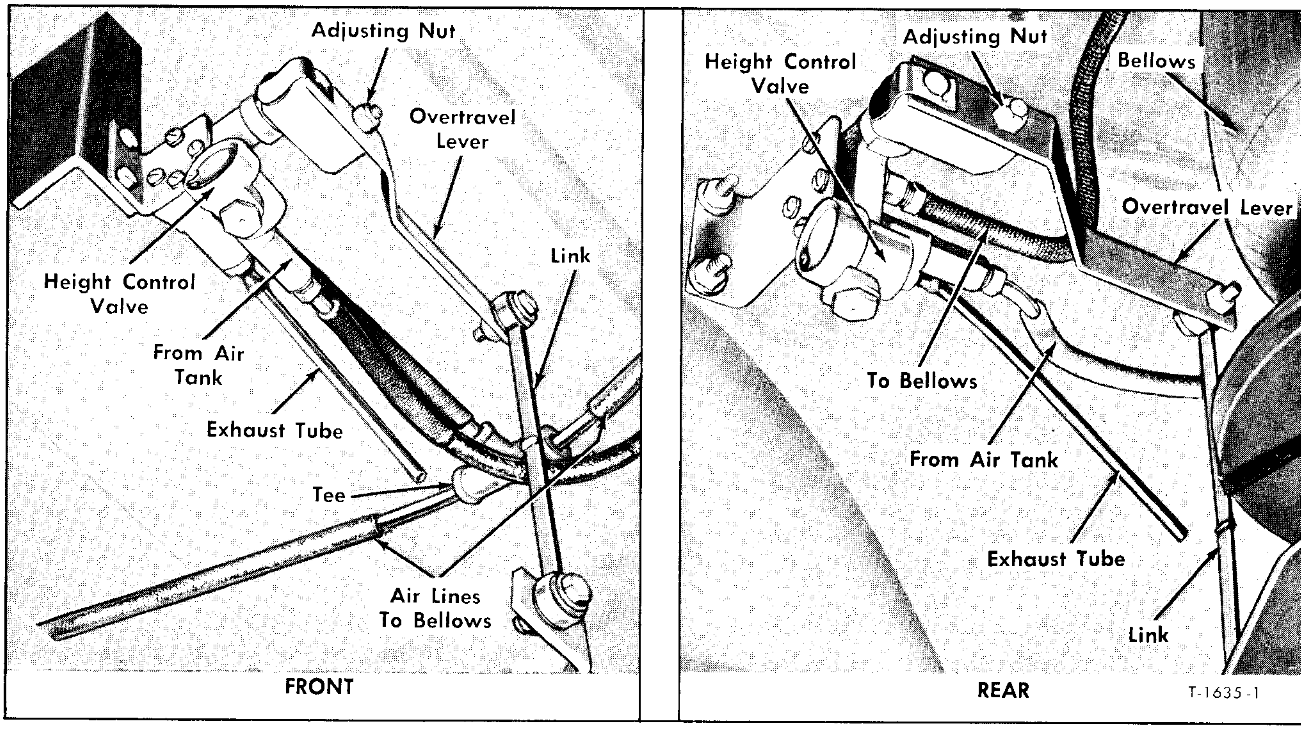


Figure 23—Height Control Valves Installed

admits tank air, but return flow of air is blocked.

NEUTRAL POSITION

As increased air pressure expands bellows and lifts body, the height control valve moves upward with body. As body is returning to normal ride height, overtravel arm and shaft return to a neutral position. Inlet valve lever also moves away from inlet valve core and inlet valve closes. This stops the flow of air into the bellows. The exhaust valve remains closed. Since the exhaust valve is closed, and the check valve in the inlet adapter

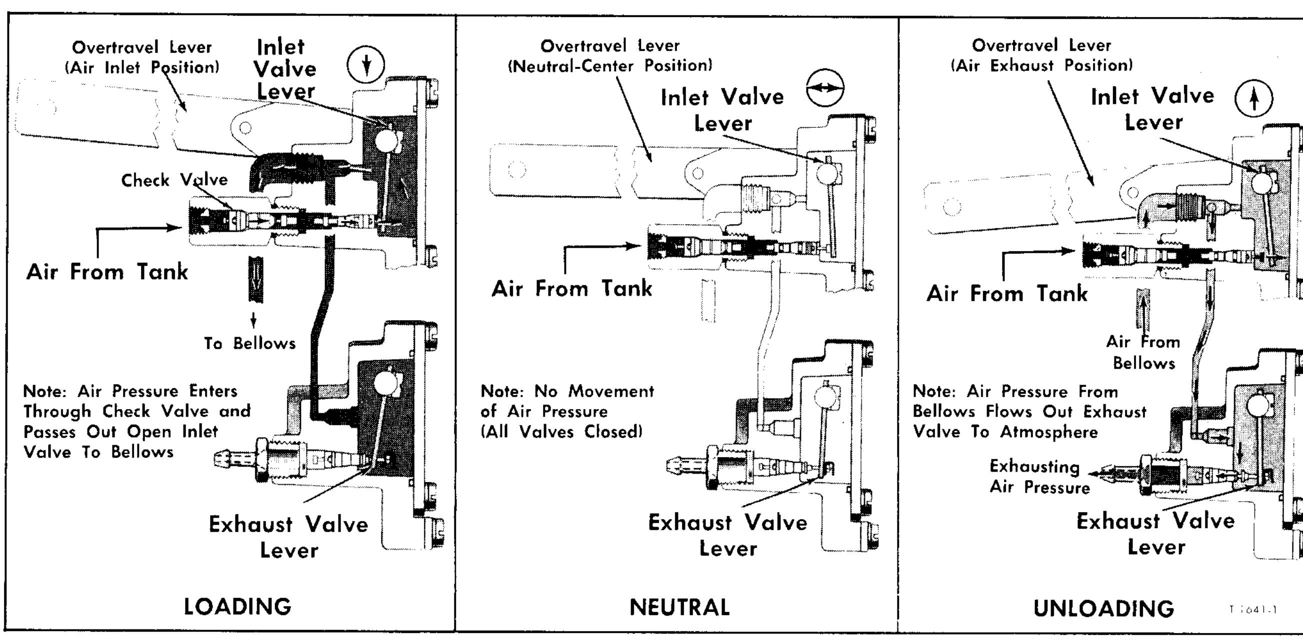


Figure 24—Operation of Height Control Valve

prevents compressed air from returning to tank, air is trapped in bellows and in valve. No further valve action or air pressure change takes place until load is increased or decreased, moving overtravel lever out of neutral position for 3 seconds or more to actuate intake valve or exhaust valve.

UNLOADING

When part of load is removed, air pressure in bellows lifts body. Overtravel lever, linked to suspension in rear and to axle in front, is pulled downward from neutral position. This applies a force on the delay piston which moves it slowly. The exhaust valve lever moves with the delay piston. The outer end of exhaust valve lever fits around stem of exhaust valve core. As soon as lever moves beyond free-travel range, lever pulls on stem and opens exhaust valve. Inlet valve remains closed. Compressed air from bellows then flows through the open exhaust valve and out exhaust fitting to atmosphere. As the compressed air is exhausted from bellows, the body lowers until overtravel lever and shaft are again in normal (neutral) position.

OVERTRAVEL LEVER FREE TRAVEL

With vehicle in motion and body at normal ride height, control valve overtravel lever and shaft are in neutral position as shown in figure 24. Small irregularities in road cause slight up and down movement of overtravel lever. Clearances are provided between operating levers and cores of inlet and exhaust valves to permit 3/16" up or down movement of overtravel lever from neutral position without causing valve action. This compensates for small road bumps. The bumps are absorbed by tires and bellows without causing movement of compressed air either into or out of suspension system.

HYDRAULIC DELAYING ACTION

Operation of delay piston (see fig. 32) in height control valve prevents change of bellows air pressure as a result of momentary road shocks, conserves air pressure, and adds life to valve. The nylon piston moves inside cylinder containing a silicone type fluid. A flapper valve on either end of piston allows displacement of fluid or acts as a check valve, depending on direction piston moves. Delay piston is moved by piston pin (see fig. 32) that is threaded into overtravel shaft. A 3 to 9 second delay results from the closing of one valve to the cracking of other valve.

Overtravel piston (see fig. 32) is held against flat side of overtravel shaft by two springs inside piston. Piston keeps overtravel shaft in proper position relative to overtravel lever. Piston also allows overtravel lever to rotate through a complete circle, if necessary, without damaging parts inside valve.

HEIGHT CONTROL VALVE REMOVAL

Before disconnecting any height control valve air lines, securely support body by placing blocks under coach at jack pads. Exhaust air from air supply system by opening drain cock in auxiliary air tank. After the above precautions have been taken, remove height control valve as follows:

1. Disconnect height control valve overtravel lever from valve link. Pull lever downward to release compressed air from bellows.
2. Disconnect air supply line and bellows air line from height control valve. Tape ends of lines closed.
3. Remove two bolts, lock washers, and nuts attaching height control valve to mounting bracket and remove valve assembly.

HEIGHT CONTROL VALVE INSTALLATION

Before installing height control valve assembly, see that air line fittings are clean and undamaged. Replace line connector rubber sleeves if deteriorated or damaged.

DO NOT USE SEALING COMPOUND ON THREADS. Sealer is unnecessary, and if used, may cause valve cores to stick.

IMPORTANT: Absolute cleanliness is essential when installing height control valves. Dirt and sealing compound must be kept out of valves. Even minute particles of foreign matter may become lodged in valve cores or flapper valves and may seriously affect operation of suspension system.

1. Position height control valve at mounting bracket. Attach with two bolts, nuts, and lock washers and tighten to torque listed in "Specifications" at end of this section.
2. Connect air supply line to intake check valve adapter. Connect bellows air line to outlet adapter. Tighten air line connector nuts firmly.

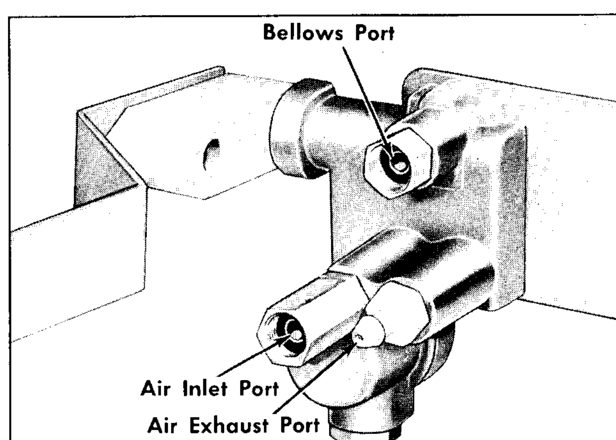


Figure 25—Identification of Valve Air Ports

3. Connect height control valve overtravel lever to valve link. Build up air pressure in system and test for leaks. Check ride height dimensions. Make adjustments as directed in the following:

HEIGHT CONTROL VALVE AIR LEAKAGE CHECK

NOTE: Air leakage check can be made when valve is installed on vehicle only for bellows mountings and air line connection leaks. The following instructions explain procedure for making air leakage check when valve assembly is removed from vehicle.

1. Clean exterior of valve assembly.
2. Connect air pressure line to air inlet port (fig. 25), then open the air pressure (80-110 psi).
3. Submerge valve assembly in a container of water, then watch for air bubbles when the overtravel lever is in the center position. No air should escape from any point of valve assembly.
4. If bubbles appear from the bellows port, this is an indication that the air inlet valve assembly is defective and must be replaced.
5. Remove air pressure line from air inlet fitting and connect it to the bellows port (fig. 25). If bubbles appear at the air inlet check valve port, this is an indication that check valve unit is defective and must be replaced.
6. If bubbles appear at the exhaust port (fig. 25), it is an indication that the exhaust valve assembly is defective and must be replaced.
7. If bubbles appear around edge of valve cover plate, the cover plate gasket must be replaced.
8. If no leaks are detected, remove valve assembly from the water, then with air pressure still connected to the bellows port, actuate overtravel lever to expel any excessive amount of water which may have entered exhaust valve chamber. Remove air line and connect it to the air inlet port and repeat operation here to remove water from air inlet valve chamber.

HEIGHT CONTROL VALVE ADJUSTMENTS

GENERAL

To properly adjust the height control valve, it is ESSENTIAL that the following procedures be followed and in the sequence mentioned.

Three main adjustments are required:
1. Overtravel lever center position adjustment.

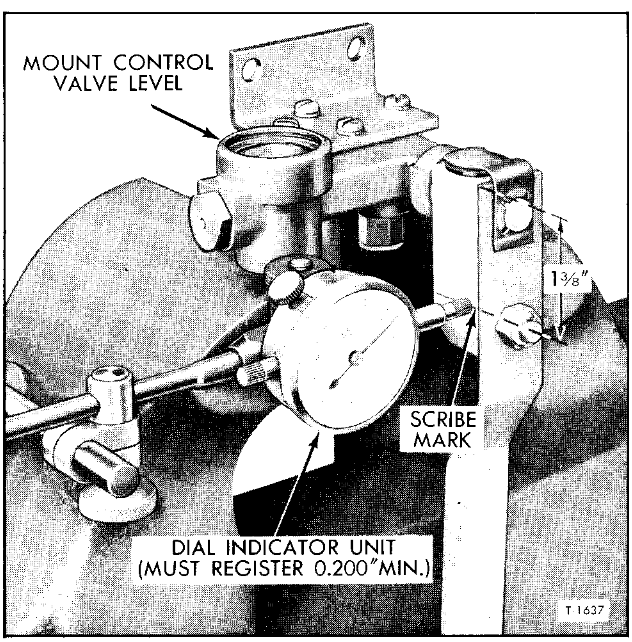


Figure 26—Dial Indicator Properly Installed

2. Air intake and exhaust valve lever gap adjustments.
3. Time delay check.

NOTE: The height control valve assembly must be removed from vehicle to make the above adjustments.

Instructions for checking the ride height dimension are explained previously under "Ride Height Check and Adjustment."

IMPORTANT: The silicone fluid should be drained from valve assembly before making the first two adjustments mentioned above.

NOTE: The following tools should be used when making valve adjustments.

REQUIRED TOOLS

Tool	Tool Number
Valve Core Replacer	J-6888
Overtravel Lever Piston Compressor	J-8424
Allen Wrenches (Sizes 3/32-inch and 1/8-inch)	Procure locally
Stop Watch	Procure locally
Dial Indicator Set (Having minimum range of 0.020 inch)	Procure locally
Air Line Fitting Assembly Consists of:	
(1) 2-Inch length of 1/4 H-9 hose	Procure locally
(1) Weatherhead pipe fitting	00904-104
(1) Weatherhead inverted fitting	00904-B04
Vacuum Line Fitting	Sun Tester #115-3
Depth Gauge and Straightedge	Procure locally
Conventional Type Eye Dropper	Procure locally

OVERTRAVEL LEVER CENTER POSITION ADJUSTMENT

1. Clean exterior of control valve assembly.
2. Remove delay piston snap ring retainer, cover, and O-ring from control valve assembly, then drain off the silicone fluid.
3. Remove exhaust fitting and exhaust screen from valve.
4. Referring to figure 26, scribe a line 1-3/8-inch from plug end of overtravel lever control body.
5. Place valve assembly in vise as shown in figure 26.
6. If vacuum source is available, attach supply hose to valve exhaust port (fig. 25) using Sun Tester fitting #115-3 or equivalent. Do not apply vacuum at this time.
7. Attach air pressure supply hose to air inlet port (fig. 25). Do not apply pressure at this time.
8. Locate dial indicator in position as shown in figure 26. Move overtravel lever to full air exhaust position - TOP OF DELAY PISTON FLUSH WITH TOP OF BORE - without overtraveling (position "C," fig. 27). Relocate indicator push rod to just contact 1-3/8 inch mark on control body and reset indicator dial to zero (0) at this point (position "C," fig. 27).
9. Move overtravel lever to full air intake position without overtraveling (position "A," fig. 27) (delay piston at bottom of bore). Take indicator reading which may vary from 0.160" to 0.190".
10. Repeat steps 8 and 9 above to recheck this reading.
11. Divide the total travel dimension by two (example: 0.170" ÷ 2 = 0.085"), then move overtravel lever back this amount (0.085") to the center (position "B," fig. 27).

IMPORTANT: Without disturbing lever center position, reset indicator dial to zero (0), which actually is 0.100" on indicator of type registering 0.100" for each revolution of indicator needle, then proceed with valve lever gap adjustments following:

AIR INTAKE AND EXHAUST VALVE LEVER ADJUSTMENTS

IMPORTANT: Before making these adjustments the overtravel lever must be centered as explained previously.

Two methods of adjustment are available:

1. Using Both Air Pressure and Vacuum.

NOTE: If vacuum source is available, this method will take less time to perform adjustment. Vacuum source is used to make the exhaust valve lever gap check only.

2. Using Air Pressure Only.

NOTE: When this method is used, it will take longer to perform adjustments as the valve cover

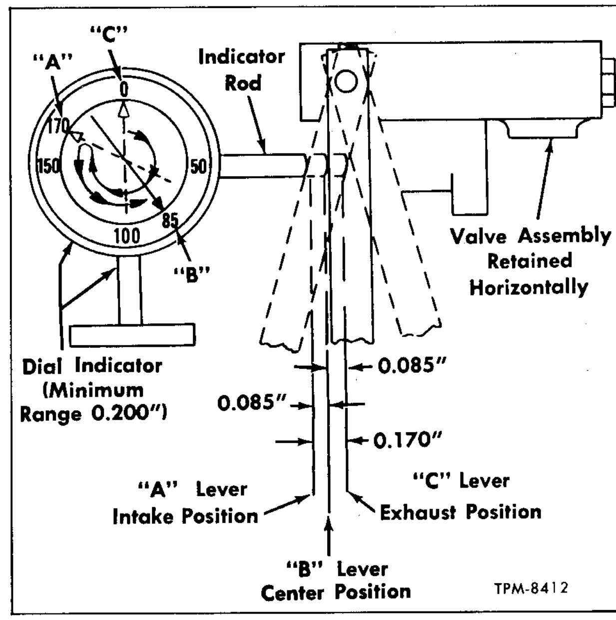


Figure 27—Locating Valve Overtravel Lever Center Position

must be in place each time air pressure is applied and then removed to permit adjustment of exhaust valve lever.

Instructions covering lever adjustments are identical for front and rear valves. Rear valve lever and front valve lever must be bent to proper setting. In these valves both exhaust and intake levers are part of one unit which contains "score" marks to permit easy bending. Mechanics may accomplish this operation with lever in the valve body, or lever may be removed and bent on the bench.

METHOD USING AIR PRESSURE AND VACUUM

1. If air supply and vacuum lines were not connected to valve assembly as directed previously when centering valve overtravel lever, connect lines.
2. Apply air pressure and regulate it to 80 to 110 psi. Apply vacuum and regulate it at approximately 15 inches.
3. Move overtravel lever fore and aft several times and then back to true center position.
4. Starting at true center position, slowly move lever to where air intake valve just begins to open. Listen for escaping air. Note reading on dial at this point. Reading should be 0.025" to 0.027" from lever center position. If necessary, bend intake valve lever to correct setting (fig. 28).
5. Return overtravel lever to center position. Slowly move lever to exhaust side and at same time note the vacuum gauge reading. When vacuum just begins to fall off, the exhaust valve has opened. Valve should open when overtravel lever is moved 0.035" to 0.037" from center position. If

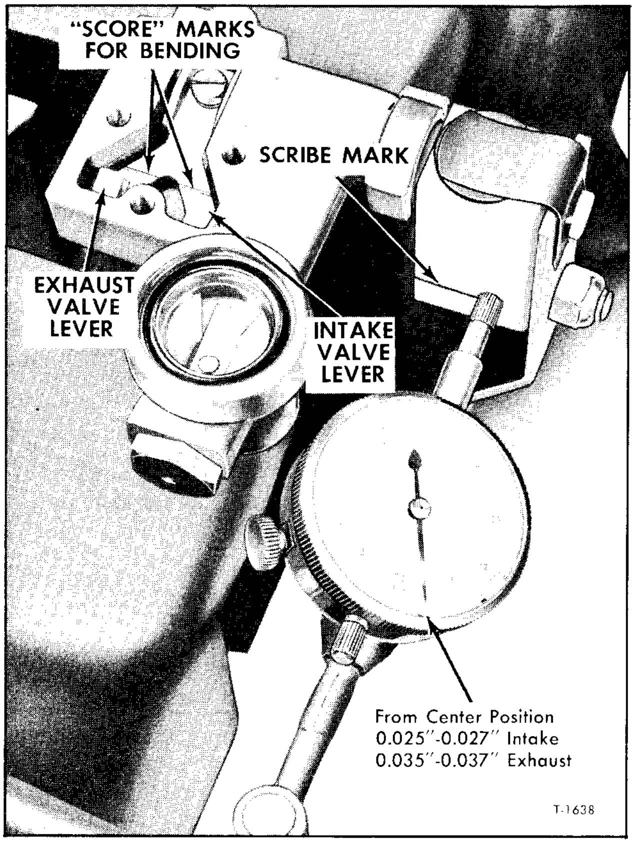


Figure 28—Adjusting Air Valve Lever Gap

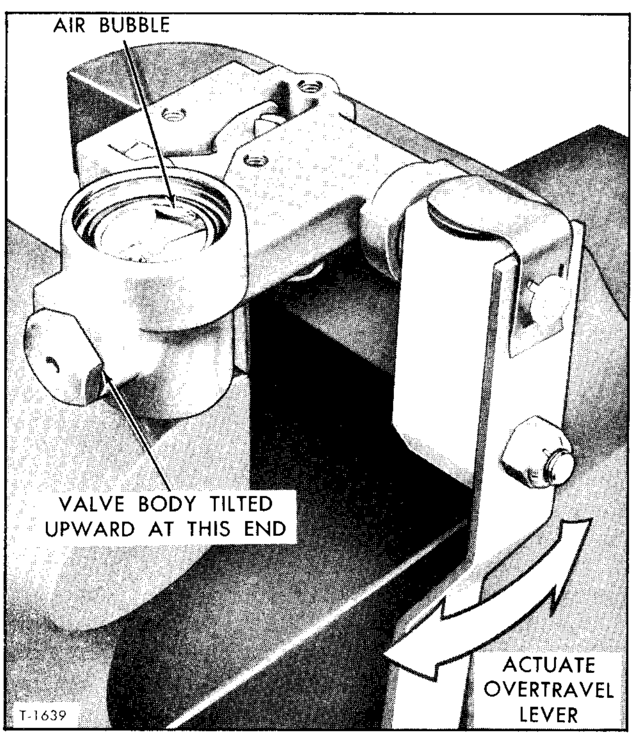


Figure 29—Venting Air from Silicone Fluid

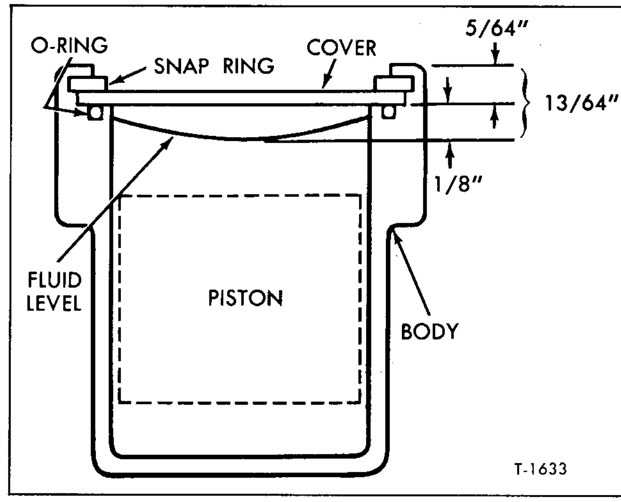


Figure 30—Silicone Fluid Level

necessary, bend exhaust valve lever to correct setting (fig. 28).

6. Recheck intake and exhaust valve lever gaps, then proceed with "Time Delay Check" explained later.

METHOD USING AIR PRESSURE ONLY

NOTE: This method may be performed when a vacuum source is not available.

1. Connect air supply hose (80 to 110 psi) to air inlet port (fig. 25).

2. To adjust air intake valve lever gap:

a. Move the overtravel lever slowly from true center position to point where intake valve just begins to open. Listen for escaping air. Note reading on dial at this point which should register 0.025" to 0.027".

b. If necessary, bend intake valve lever to correct setting (fig. 28).

3. To adjust air exhaust valve lever gap:

a. Install valve cover on the valve using a new gasket and four attaching screws.

b. Being careful not to disturb indicator setting, disconnect air supply from the air inlet port and connect it to the bellows port (fig. 25).

c. Move overtravel lever slowly to open exhaust port while observing the indicator dial. Air should start to escape from exhaust port when indicator registers 0.035" to 0.037". If adjustment is necessary, shut off air pressure supply and remove valve cover. Bend exhaust valve lever to correct setting; then install cover and recheck valve opening dimension.

d. Recheck valve lever gaps, then proceed with "Time Delay Check" following:

TIME DELAY CHECK

PRELIMINARY PROCEDURES

After the valve lever gaps have been properly adjusted, the time delay check must be performed. A 3 to 9 second delay from the closing of one valve to the opening of the other is recommended.

1. Place new O-ring over delay plug, then install plug into valve body. Tighten plug to torque listed in "Specifications."

2. Pour 6.0 cc $\pm$ 0.25 cc of Silicone fluid (1000 Centistokes viscosity at 25°C) into delay piston bore. With valve body tilted slightly as shown in figure 29 carefully operate overtravel lever fore and aft to vent air from fluid. When all air has been expelled from piston pin cavity, check fluid level using depth gauge as shown in figure 30.

IMPORTANT: With valve assembly level, take measurement from center of bore only. Add or remove fluid to bring fluid 13/64 inch from top of valve body. An eyedropper will serve for this purpose.

3. Place new delay piston cover O-ring in groove of valve body. Install cover with snap ring retainer.

4. Place valve assembly vertically in holding vise (fig. 31).

5. Move overtravel lever up and down for approximately one minute.

AIR INLET TIME DELAY CHECK

1. Connect air pressure supply hose to valve air inlet port (fig. 25).

2. Move the overtravel lever upward (quickly) approximately two inches and simultaneously start counting the number of seconds before air starts to escape from bellows port. A delay of 3 to 9 seconds should exist. Repeat this check.

AIR EXHAUST TIME DELAY CHECK

To time the delay for exhaust, two methods can be used; one using vacuum source and one using air pressure.

1. Method Using Vacuum

a. Connect vacuum hose to air exhaust port (fig. 25). Adjust vacuum to 15 inches.

b. Move the overtravel lever downward (quickly) approximately two inches and simultaneously start counting the number of seconds before the vacuum gauge starts to drop off. A delay of 3 to 9 seconds should exist. Repeat this check.

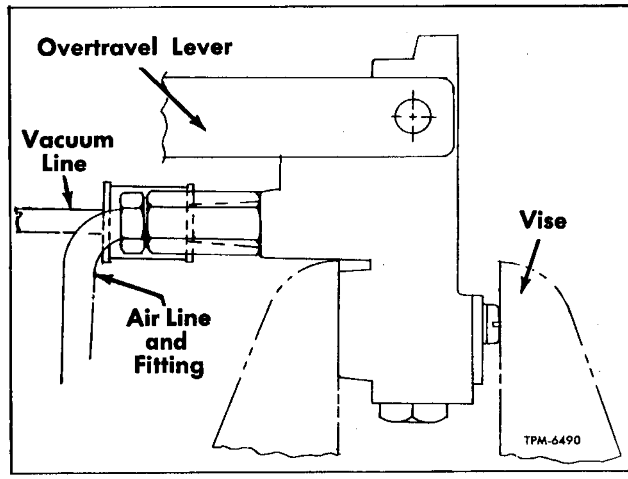


Figure 31—Valve Positioned for Time Delay Check

2. Method Using Air Pressure

a. Install valve cover with new gasket on valve assembly.

b. Connect air pressure supply hose to bellows port (fig. 25).

c. Move overtravel lever downward (quickly) approximately two inches and simultaneously start counting the seconds before air starts to escape from the exhaust port. A delay of 3 to 9 seconds should exist.

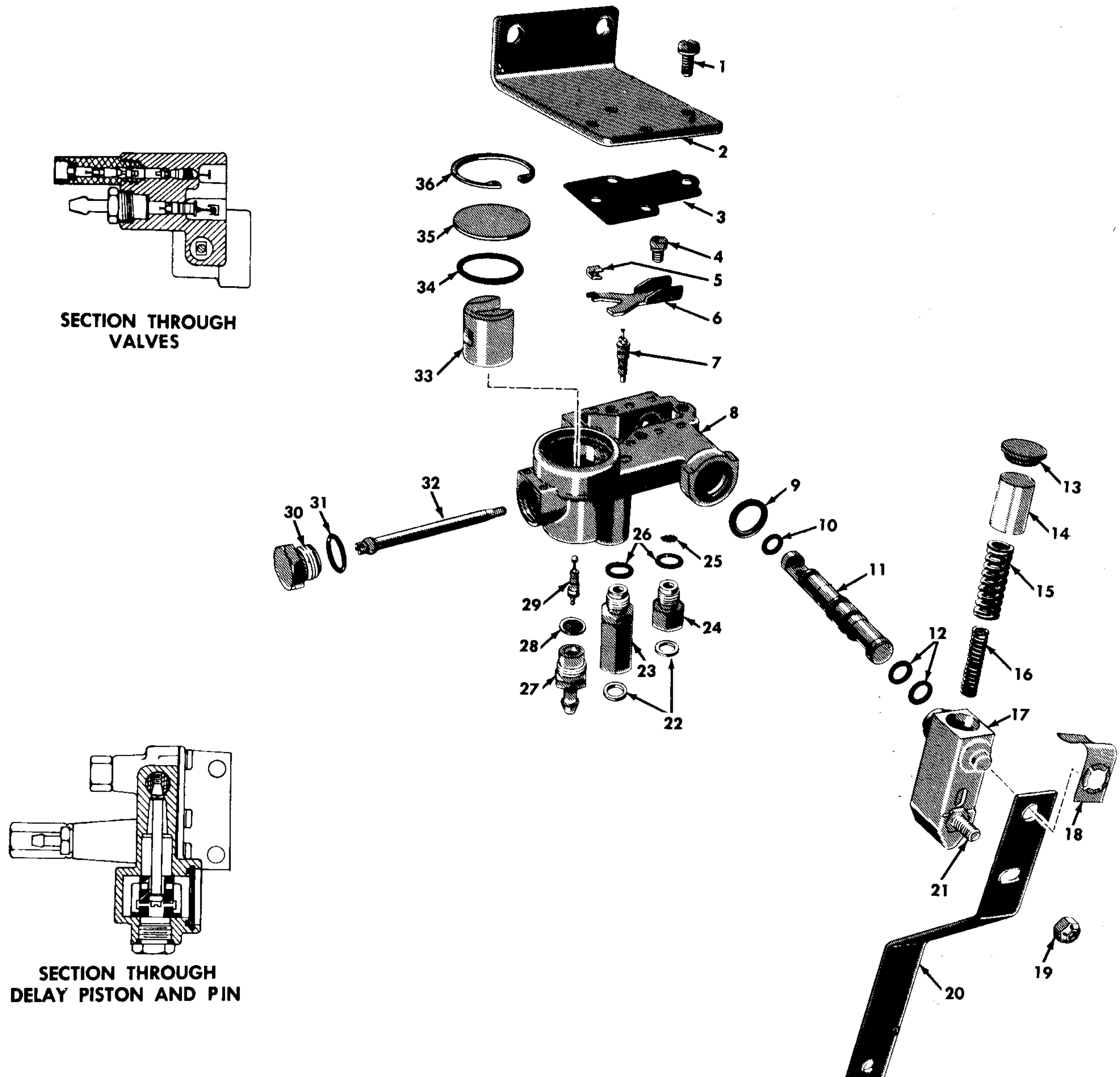
IMPORTANT: A time delay over 9 seconds could mean too large a valve lever gap adjustment and a time delay under 3 seconds would mean too small a valve lever gap adjustment. If the time delay is not within 3 to 9 seconds, first recheck the fluid level. If fluid level is satisfactory, the valve lever gap adjustment must be repeated, step by step.

NOTE: After obtaining proper valve adjustments, install valve cover using new gasket. Install new screen in bellows port, then using new O-ring, install outlet adapter into bellows port. If screen was removed from exhaust port, install new screen and exhaust fitting. Install air line gaskets.

NOTE: Place tape over ends of air line ports until such time as valve assembly is installed on vehicle.

HEIGHT CONTROL VALVE OVERHAUL

Height control valves meter air into and out of the air suspension system. These valves are precision built and accurately adjusted. Parts must be carefully handled and assembled. Valves must also be accurately adjusted to insure proper operation after rebuild. Special tools mentioned previously should be used. Makeshift tools may break off chips that could lodge between valve and seats. Chips, dirt, and other foreign material could cause faulty valve operation.



1 Cover Screw and Lock Washer
2 Cover and Bracket
3 Cover Gasket
4 Valve Lever Screw
5 Valve Stem Lock Clip
6 Intake and Exhaust Valve Lever
7 Intake Valve Core
8 Valve Body
9 Overtravel Control Body Seal
10 Shaft O-ring (Medium)
11 Overtravel Control Shaft
12 Shaft O-ring (Large)
13 Overtravel Body Plug
14 Overtravel Piston
15 Overtravel Spring (Large)
16 Overtravel Spring (Small)
17 Overtravel Control Body
18 Plug Retainer
19 Lever Stud Nut
20 Overtravel Lever
21 Overtravel Lever Stud
22 Airline Fitting Gasket
23 Inlet Adapter and Check Valve Assembly
24 Outlet Adapter
25 Outlet Adapter Screen
26 Adapter O-ring
27 Exhaust Fitting
28 Exhaust Screen
29 Exhaust Valve Core
30 Delay Plug
31 Plug O-ring
32 Piston Pin
33 Delay Piston
34 Delay Cover O-ring
35 Delay Cover
36 Delay Cover Retainer

T-1446

Figure 32—Height Control Valve Components

NOTE: Repair parts kit is available which contains all parts usually requiring replacement in average overhaul.

FRONT AND REAR CONTROL VALVES

The following procedures cover disassembly, cleaning, inspection, and assembly of the valves used at front and rear of all coaches.

DISASSEMBLY (Refer to Fig. 32)

1. Remove inlet adapter and check valve assembly (23) from valve body (8). Remove outlet adapter (24). Remove adapter O-rings (26). Remove air line fitting gasket (22) from adapters. Remove outlet adapter screen (25).
2. Remove four cover screws and lock washers (1) from cover and bracket (2). Remove cover and bracket and gasket (3).
3. Position valve with delay plug (30) at top. Unscrew delay plug from valve body (8). Drain silicone fluid from cavity. Remove plug O-ring (31). Unscrew piston pin (32) from control shaft (11).
4. Remove delay cover retainer (36), cover (35) and cover O-ring (34). Remove delay piston (33). Discard O-ring.
5. Remove valve lever screw and lock washer (4) from valve lever. Remove exhaust valve and intake valve lever (6) from valve body.
6. Remove valve stem lock clip (5) from stem of exhaust valve core. Spread locking arms and slide clip from around stem.
7. Pull overtravel assembly and shaft from valve body.
8. Remove intake valve core (7) with tool J-6888 as shown in figure 14.
9. Remove exhaust fitting (27) and screen (28), then remove exhaust valve core (29) with tool J-6888 as shown in figure 14.
10. Remove plug retainer (18) from overtravel control body (17). Retainer must be cut off. Use caution to avoid damage to nylon body. Remove overtravel body plug (13).
11. Place forked end of tool J-8424 around shaft in overtravel control body, then tighten clamp screw. See figure 34.

CAUTION

TIGHTEN TOOL UNTIL OVERTRAVEL CONTROL SHAFT (11) CAN BE TURNED 90° TO ALLOW NOTCH IN SHAFT TO PASS FREE OF OVERTRAVEL PISTON (14). DO NOT APPLY MORE PRESSURE THAN IS REQUIRED.

Remove overtravel control shaft (11) and overtravel control body seal (9) from body. Remove shaft O-rings (10 and 12). Back off vise jaw and take body and tool from vise. Remove tool, overtravel piston (14), overtravel lever large spring (15), and overtravel lever small spring (16) from body. Remove lever screw nut (19) from overtravel lever screw or stud. Remove lever (20) from body.

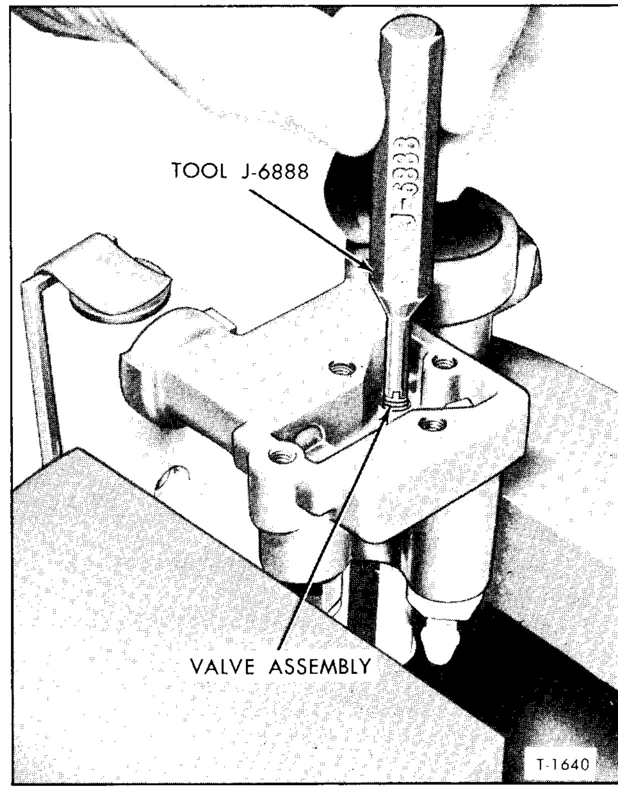


Figure 33—Replacing Valve Core Assemblies

CLEANING AND INSPECTION

1. The following parts should be discarded and replaced with new parts at each overhaul: Plug retainer (18), overtravel control body seal (9), gasket (3), and O-rings (10, 12, 26, 31 and 34).
2. Thoroughly clean all metallic parts in a suitable cleaning solvent. Blow parts dry with compressed air.
3. Inspect all bearing and rubbing surfaces for scoring, fractures, or noticeable wear. Discard all damaged or worn parts and replace with new parts.

ASSEMBLY

CAUTION: HEIGHT CONTROL VALVE PARTS MUST BE KEPT FREE FROM DIRT AND MOISTURE.

1. Install intake valve core (7) and exhaust valve core (29) in control body (17) with tool J-6888 in manner shown in figure 33. Tighten to torque listed in "Specifications."
2. Lubricate overtravel control body with multi-purpose grease. Assemble overtravel components as follows:

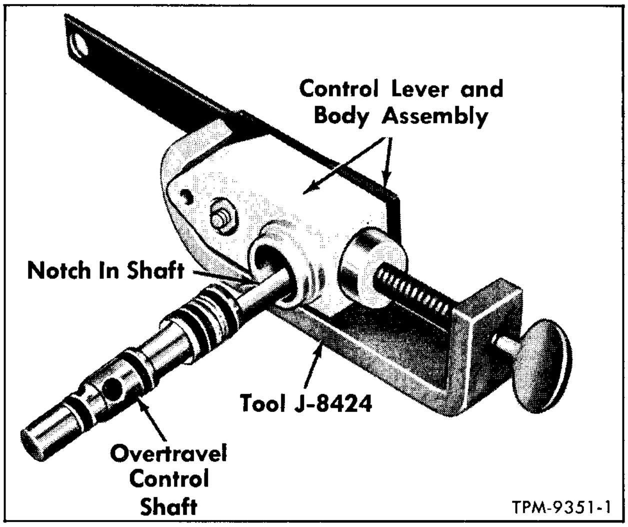


Figure 34—Replacing Overtravel Lever

a. Install overtravel lever (20) on control body. Place lever stud nut (19) on stud and tighten to torque listed in "Specifications."

b. Place overtravel lever large spring (15), and overtravel lever small spring (16) inside piston (14). Insert piston in control body (17).

c. Place three new O-rings (10 and 12) on overtravel control shaft (11). Lubricate shaft and O-rings with multi-purpose grease.

d. Position fork of tool (J-8424) so that shaft can be inserted in body. Carefully apply pressure with clamp screw (fig. 34). Compress springs only enough to allow shaft to be inserted. Install overtravel control shaft (11). Rotate shaft so that flat is next to piston.

e. Insert overtravel body plug (13) in bore of body. Force new plug retainer (18) in position over nylon pivot and body plug (13).

f. Place new overtravel control body seal (9) on shoulder of body. Slide overtravel assembly

TROUBLESHOOTING HEIGHT CONTROL VALVE

MALFUNCTION	POSSIBLE CAUSE	CORRECTIVE MEASURE
1. Bellows deflate overnight.	a. Defective check valve assembly.	a. Replace check valve assembly.
	b. Defective exhaust valve assembly.	b. Replace exhaust valve assembly.
	c. Leak in air line and/or bellows.	c. Replace air line or bellows.
	d. Defective valve cover rubber O-rings or gasket.	d. Replace valve cover O-rings or gasket.
2. Bellows raise to full height and fail to exhaust air pressure.	a. A clogged exhaust screen in height control valve assembly.	a. Remove, then clean screen.
	b. A combination clogged exhaust screen and a defective air inlet valve assembly.	b. Clean exhaust screen and replace air inlet valve assembly.
3. Intermittent hissing noise at height control valve during operation.	a. Loss of time delay action fluid in height control valve assembly.	a. Add fluid, then install new cover and delay piston plug gasket O-rings.
4. Erratic valve action.	a. Dirt or foreign matter in the air valve lever chamber.	a. Remove valve cover and blow out dirt. Install cover using new gasket.
	b. Defective valves.	b. Overhaul height control valve assembly.
5. Vehicle body fails to level out.	a. Improper height control valve overtravel lever adjustment.	a. Make proper adjustments as directed previously under "Ride Height Check and Adjustment."

into valve body (8). Insert carefully to avoid seal damage.

3. Install time delay assembly as follows:

a. Place delay piston (33) in valve body with open side of piston toward the overtravel shaft (11).

b. Align pin openings in piston and in shaft. Fit piston pin (32) in TAPERED SIDE of hole in shaft. Tighten pin to torque listed in "Specifications."

4. Place intake valve and exhaust valve lever (6) in position on overtravel shaft. Make sure the fork on the exhaust lever side is around stem of exhaust valve core (29). Fork should be high enough on stem so that stem will not be held open. Insert valve lever screw (4) and tighten to torque listed in "Specifications."

5. Spread ends of valve stem lock clip (5) slightly and place on exhaust valve stem around stem head. Use suitable tool to brace stem and pinch ends of clip just enough to secure on stem. Clip must rotate freely on stem.

6. Using new O-ring (26), install air inlet adapter and check valve assembly (23) into valve body.

7. Make all of the valve assembly adjustments explained under "Height Control Valve Adjustments" on pages earlier in this section.

SHOCK ABSORBERS

DESCRIPTION

Shock absorbers used at front and at rear axles are double-acting, telescoping type. Lower mountings are eye-type and upper mountings are bayonet-type .

SHOCK ABSORBER OPERATION

The main function of a shock absorber is to regulate vehicle travel by dampening the motion of the air bellows caused by normal road travel. The operation of the hydraulic shock is rather simple. Fluid contained within the shock is forced through a restricted opening by a piston when the suspension air bellows are flexed. Since fluids are not compressible under ordinary pressures, the fluid takes a certain time to flow through the restricted opening.

The energy of road shocks imposed on the air bellows is dissipated and regulated by the shock absorber. This prevents sudden jolts and bounces from being transmitted to the vehicle body and its occupants and cargo.

SHOCK ABSORBER SERVICE

Shock absorbers are of welded construction and cannot be repaired. Shock absorber not operating properly should be replaced with a new unit.

SHOCK ABSORBER REMOVAL

Remove nut and washer from lower anchor pin, and nut, retainers, and upper bushing from upper anchor pin.

Pull shock absorber and rubber bushings from lower anchor pin; then pull shock from upper mounting hole. It is recommended that all rubber bushings be discarded and replaced with new items.

SHOCK ABSORBER INSTALLATION

Make sure shock absorber mounting eye and anchor pins are clean. Place lower bushing and retainer on upper anchor pin and insert shock in mounting hole. Place rubber bushing on lower anchor pin and install shock on anchor pin. Install second rubber bushing, washer and hand tighten nut on lower anchor pin. Install upper bushing retainers, and hand tighten nut on upper anchor pin. Tighten upper and lower anchor pin nuts to torque listed in "Specifications."

Refer to next page for "Specifications."

SPECIFICATIONS

AIR BELLOWS

	FRONT	REAR
Part Number (Molded on Bellows)—Goodyear	2499059	2475048
Diameter	9″	10″

HEIGHT CONTROL VALVES

Make.......Delco Products
Model No. (Stamped on Valve Cap)
Front.......5549705
Right Rear.......5549704
Left Rear.......5549703

SHOCK ABSORBERS

Make.......Delco Products
Type.......Double-Acting, Telescoping
Identification (Stamped on Unit)
Part Number—Rear.......3182842
Front.......3192416
Valve Code —Rear.......C6(6)G(313)/j3
Front.......C5(6)N(313)/j3
Collapsed Length*.......15.844″ ± 0.125″
Extended Length*.......24.812″ ± 0.125″
Travel.......8.968″ ± 0.25″
*Length measured from center of lower mounting eye to shoulder of upper anchor pin.

TORQUE SPECIFICATIONS

HEIGHT CONTROL VALVE

Valve Cores.......2½-3 in. lbs.
Intake and Exhaust Valve Lever Screws.......10-15 in. lbs.
Piston Pin.......8-10 in. lbs.
Delay Plug.......20-30 in. lbs.
Cover Screw.......15-20 in. lbs.
Adj. Nut.......70-80 in. lbs.

FRONT SUSPENSION COMPONENTS

	Ft.-Lbs.
Lower Radius Rod Bracket to Support Stud Nut	190-210
Lower Radius Rod to Axle Bracket Cap Screw	290-330
Lower Radius Rod Anchor Plate to Frame Bracket Bolt Nut	190-210
Upper Radius Rod to Frame Anchor Pin Cap Screw	290-330
Upper Radius Rod to Support Anchor Pin Cap Screw	290-330
Suspension Support U-Bolt Nut	90-110
Bellows Mounting Plate to Frame Bracket Bolt Nut	15-20
Bellows to Mounting Plate Stud Nut	8-10
Bellows to Mounting Plate Airline Stud Nut	15-20
Bellows to Support Stud Nut	8-10
Height Control Valve to Mounting Bracket Bolt Nut	6-7
Height Control Valve Link Mounting Bolt Nut	6-7
Shock Absorber Mounting Stud Nut	60-70

REAR SUSPENSION COMPONENTS

Radius Rod Bracket to Axle Housing Stud Nut	190-210
Suspension Support to Axle Bolt Nut	200-220
Lower Radius Rod to Support Anchor Pin Cap Screw	290-330
Lower Radius Rod to Frame Bracket Bolt Nut	190-210
Upper Radius Rod to Frame Bracket Bolt Nut	190-210
Upper Radius Rod to Axle Bracket Cap Screw	290-330
Bellows to Support Stud Nut	8-10
Mounting Plate to Beam Bolt Nut	20-25
Bellows to Mounting Plate Air Line Stud Nut	15-20
Bellows to Mounting Plate Stud Nut	8-10
Stabilizer Bar Bracket to Anchor Plate Bolt Nut	20-25
Stabilizer Bar Retainer Clamp Bolt Nut	20-25
Stabilizer Bar Link Nut	175 min.
Shock Absorber Mounting Stud Nut	60-70

Steering System

This group includes maintenance information on both mechanical and power steering systems used on coaches covered by this manual. The power units used in conjunction with the conventional mechanical steering units are covered under "POWER STEERING" section later in this group. All other information applies to both systems with exceptions noted in text. This group is divided into two separate sections as shown in the following Index:

Mechanical Steering

GENERAL

Two types of steering systems are used on these coaches - Conventional Mechanical Steering as standard equipment and Power Steering as optional equipment.

The mechanical steering system (fig. 1), is composed of steering wheel, steering column and bevel gear assembly, two steering propeller shafts and support, steering gear assembly, and allied parts of the front axle.

Related front end assemblies which may affect steering operations are: Air Suspension, Brakes, Wheel Bearings, Front Axle, and Front End Alignment. These are covered in their respective sections in this manual.

The mechanical steering gear (fig. 11) is a conventional recirculating ball bearing and sector nut type, mounted on the front axle center and connected to the steering column bevel gear unit by two propeller shafts as shown in figure 1.

When a coach is equipped with power steering, a booster cylinder assembly is added to the system at front axle. Also, a power steering pump mounted at rear of engine is added to the system. Hydraulic fluid lines connect the booster cylinder to the hydraulic pump. The power steering units are described later in the "POWER STEERING" section.

Specifications and other pertinent steering system information is given in "Specifications" at the end of each section.

CONSTRUCTION AND OPERATION

MOUNTING (Fig. 1)

Mechanical steering system installation is illustrated in figure 1. Steering column and bevel gear housing assembly is bolted to a bracket on left-hand frame longitudinal member, with steering column extending upward through floor, Steering column is supported at coach floor and bevel gear by supports, plates, and brackets.

Steering gear assembly is mounted on support brackets on front axle center. Position of the gear assembly on axle center is maintained by two bolts through the gear housing flange into the front of the axle center. Support brackets are attached to axle center with U-bolts. Steering gear is mounted with Pitman shaft pointing down. Pitman arm extends rearward under axle and is connected to the drag link. Drag link is connected to steering arm at left front wheel.

Operation of steering system is essentially the same as a conventional type, except that the steering gear is mounted on front axle. Steering effort is therefore transmitted from bevel gear unit to steering gear through two steering propeller shafts. Movement of steering gear Pitman shaft is transmitted to front wheels through Pitman arm, drag link, steering knuckle arm, and tie rod.

STEERING COLUMN AND BEVEL GEAR

Steering column is composed of steering wheel (fig. 3), upper shaft and jacket (fig. 3), universal joint (fig. 5), lower shaft and jacket (fig. 5), and bevel gear (fig. 2). Steering wheel mounts on serrated upper end of steering shaft and secured with a nut. Horn contact, spring, button, and components are mounted on upper end of shaft and in center of steering wheel as shown in figure 3.

Steering column upper shaft is supported at upper end by a ball bearing in the directional switch assembly. Lower end of upper shaft is attached to lower shaft by means of a universal joint assembly (fig. 5).

Steering column lower shaft is supported at upper end by a roller bearing pressed into lower

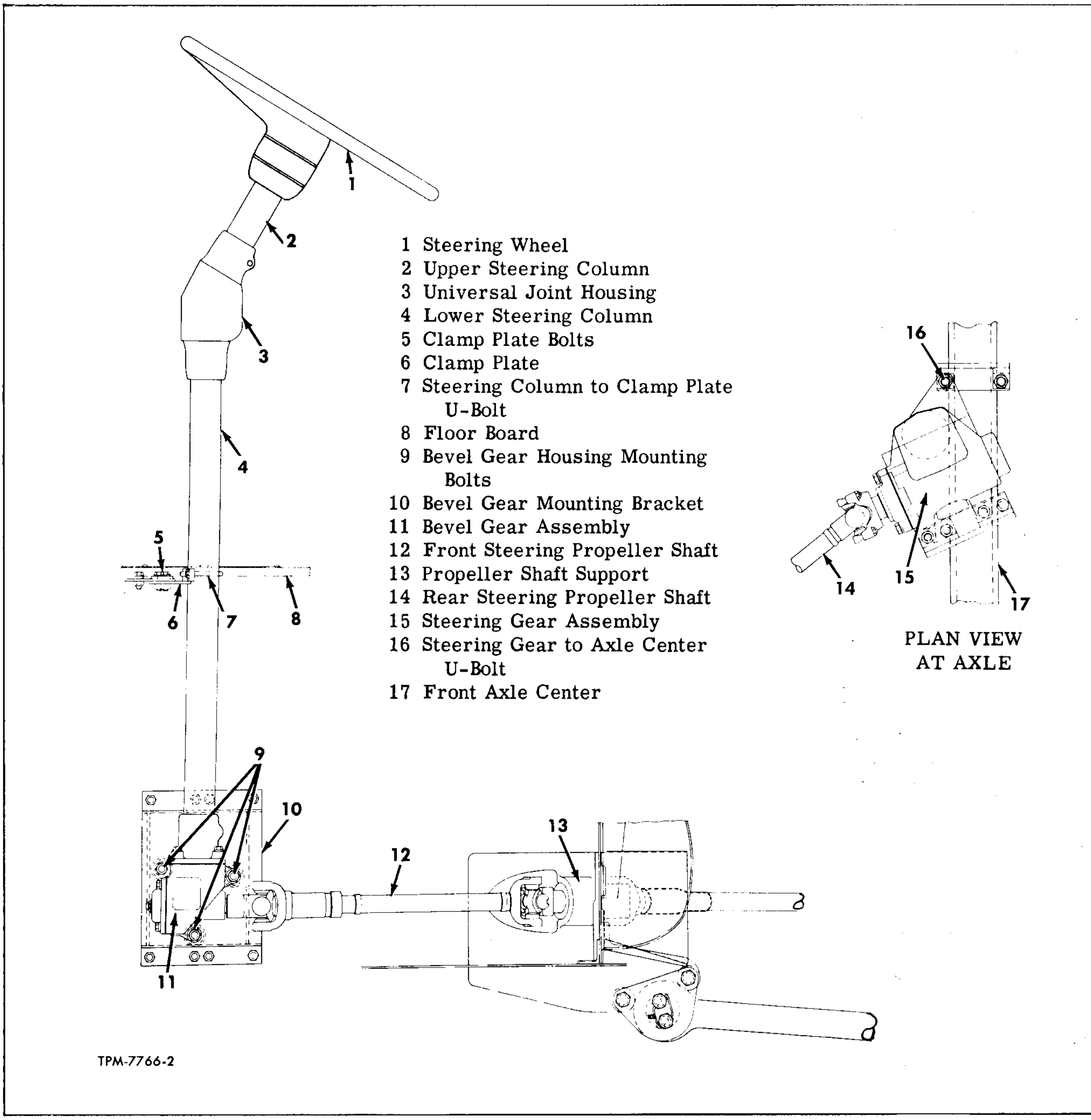


Figure 1—Mechanical Steering System

column jacket. Upper end of lower shaft is attached to lower end of upper shaft by a universal joint assembly (fig. 5). Lower end of lower shaft is secured to bevel gear pinion gear by means of a Woodruff key and lock nut (fig. 2).

Bevel gear housing upper cover is pressed onto and riveted to steering column tube. Steering shaft pinion gear is pressed onto steering shaft and secured with Woodruff key and lock nut. The upper pinion gear is mounted in roller needle bearings in bevel gear housing upper cover. Upper pinion gear is adjustable toward lower bevel gear by means of shims used between gear housing upper cover and bevel gear housing.

Lower bevel gear is mounted in needle bearings in bevel gear housing and housing cap assembly, and is adjustable toward steering shaft pinion gear by means of an adjusting screw. Steering propeller shaft yoke is keyed to lower bevel gear and is secured by a pinch bolt.

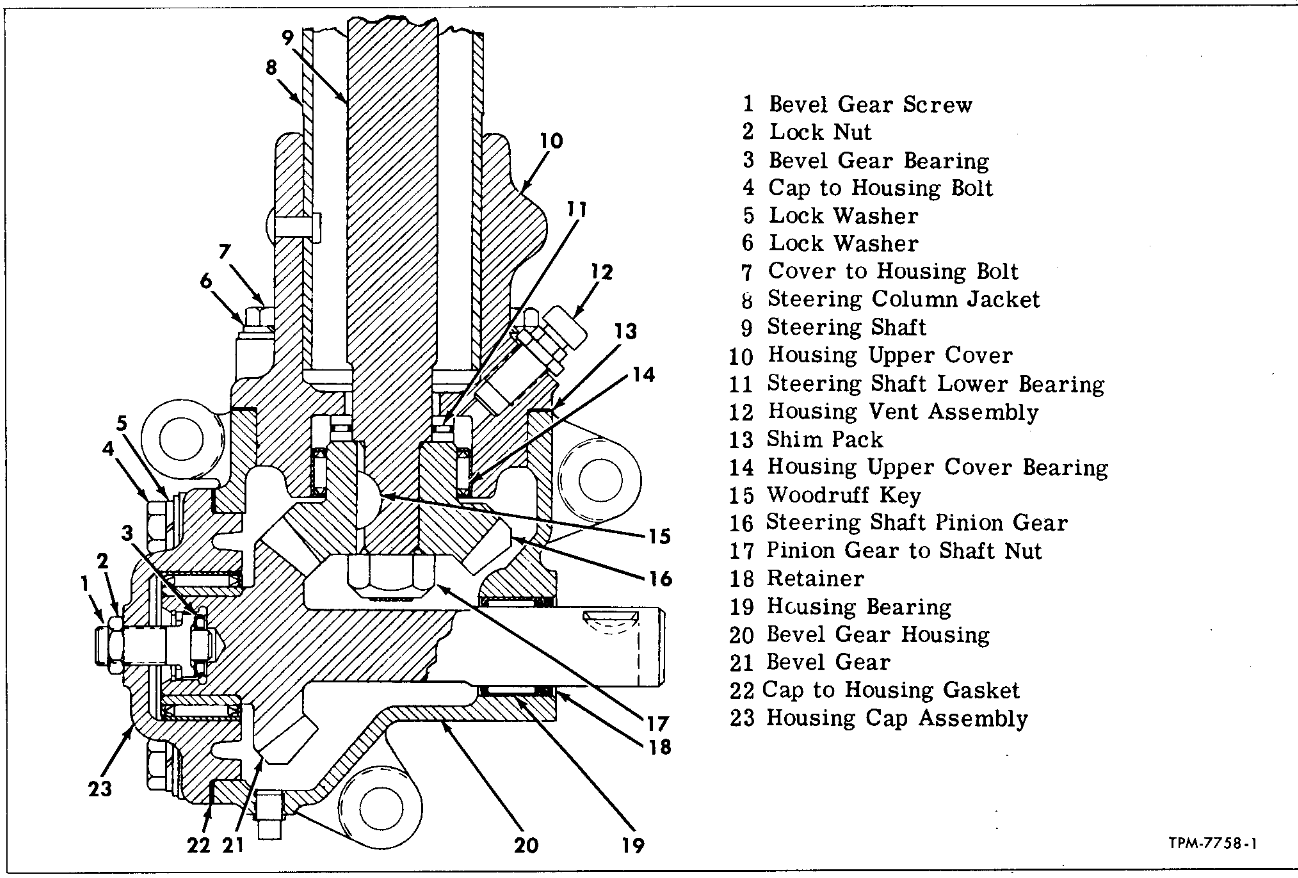


Figure 2—Steering Column Bevel Gear

STEERING PROPELLER SHAFTS

Steering propeller shafts and propeller shaft bearing support assembly, which transmit motion from steering column to the steering gear, are shown in figure 1. Propeller shafts (fig. 9) are tubular type equipped with needle bearing type universal joints at each end, also a splined slip joint to absorb endwise movement. The propeller shaft bearing support assembly (fig. 10) is supported by a bracket riveted to coach understructure.

WORM SHAFT AND NUT (Fig. 11)

The steering worm, which is welded to worm shaft, is mounted in steering gear housing between two tapered roller bearings. Bearings are adjusted to control worm end play by means of shims used between the housing top cover and the gear housing. Helical cut groove in worm is precision finished to serve as a race for balls between worm and worm nut. Bore of worm nut is threaded with a precision finished helical groove corresponding to groove in worm. Worm nut balls are inserted in helical grooves between worm and worm nut in two separate circuits. Two tubular ball guides fit into worm nut and are clamped in place. These guides deflect worm nut balls from end of circuit in worm nut, returning them to helical path at start of circuit. Worm nut balls are the only contact between worm and nut. When worm is turned, worm ball nut moves along worm and at the same time, worm nut balls roll freely between worm and nut, circulating within their separate circuits. This arrangement provides a rolling instead of a sliding contact between parts.

Rack teeth on one side of worm nut mesh with teeth on Pitman shaft; thus, endwise movement of worm nut causes Pitman shaft to rotate.

Shaft yoke is keyed to propeller shaft end of worm and secured with a pinch bolt. An oil seal is pressed into gear housing. Seal wipes on shaft yoke hub.

PITMAN SHAFT (Fig. 11)

Teeth on Pitman shaft are not the ordinary spur gear type, but are specially designed to provide true rack and sector gear action when worm nut is positioned at a slight angle. This construction permits simple lash adjustment by shifting the Pitman shaft along its axis by means of the lash adjuster screw. With Pitman shaft adjusted to eliminate all lash at straight-ahead position, sector teeth design provides a slight lash when wheels

are turned far to right or left. This design permits adjustment for wear of sector teeth in straight-ahead position without causing binding of teeth in less used portion of sector (extreme left or right position).

Pitman shaft is mounted on three needle type roller bearing assemblies, two in gear housing and one in housing side cover. An oil seal is pressed into housing at Pitman arm end of Pitman shaft.

MAINTENANCE

The following light maintenance operations include inspection and adjustment items which may be accomplished without removing the steering gear from the vehicle.

1. At regular intervals, check and if necessary, tighten all steering gear mounting bolts, bevel gear housing mounting bolts, propeller shaft yoke bolts, Pitman arm retaining nut, drag link to Pitman arm and steering arm retaining nuts, tie rod to steering arm retaining nuts, and all assembly bolts on steering gear and bevel gear housing.
2. Check steering gear adjustments and adjust if necessary. Refer to "Steering Gear Adjustments" later in this section.
3. Check front end alignment: Refer to "FRONT END ALIGNMENT" (SEC. 1) of this manual.
4. Lubricate steering gear and allied units at regular intervals as indicated in LUBRICATION (SEC. 13) of this manual.

STEERING GEAR ADJUSTMENTS

Before an attempt is made to remedy steering difficulties by adjusting the steering gear, other factors which might cause hard or otherwise unsatisfactory steering should be checked. Particular attention should be given to tire inflation, lubrication, wheel bearings, brakes, air suspension, front end alignment, and worn, bent, or broken front axle parts.

It is important that steering gear be properly adjusted to assure satisfactory steering and to prevent excessive wear of parts. Adjustments are provided for worm bearing end play and Pitman shaft lash.

Always check worm bearing adjustment, and adjust if necessary, prior to making Pitman shaft lash adjustment.

Before making adjustments, the following preliminary operations are necessary:

1. Disconnect steering drag link from steering gear Pitman arm by removing nut from end stud and driving end stud out of arm. Drag link should remain disconnected until all steering gear adjustments are completed.
2. Disconnect propeller shaft universal joint yoke from yoke on steering gear worm shaft by removing U-bolts and lock nuts. Obtain a bar which can be bolted to worm yoke, with a hole in bar 9 inches from center of worm.

WORM BEARING CHECK AND ADJUSTMENT

Key numbers in text refer to figure 11.

1. Loosen lash adjuster lock nut (2) and turn lash adjuster screw (1) counterclockwise a few turns. This relieves load imposed on worm bearings by close meshing of teeth on worm nut and Pitman shaft sector gear.
2. Gently turn worm to either extreme left or right position; then back away about one turn.

IMPORTANT: Do not turn worm hard to end of travel with linkage disconnected or ball guides on worm nut may be damaged.

3. Bolt bar previously obtained to worm shaft yoke (35), and attach spring scale (J-544-01) to bar 9 inches from center of worm. Pulling on spring scale at right angle to bar, measure pull required to keep worm in motion. Pull required must be within 1-1/2 to 2 pounds, otherwise worm bearing adjustment is required.

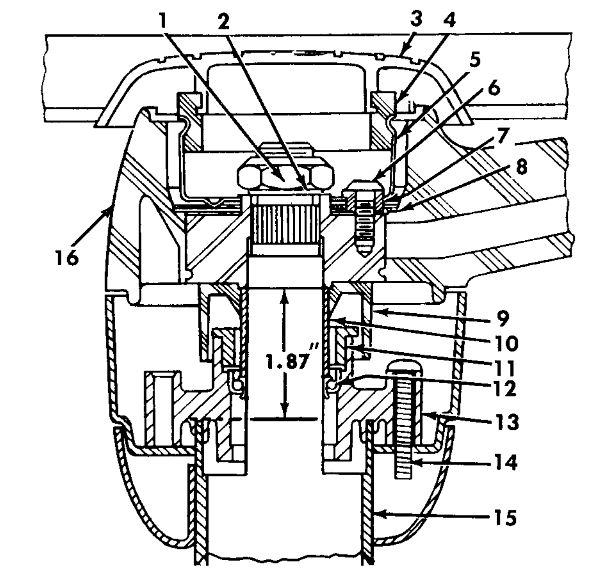
NOTE: If any "rough" or "lumpy" action is noted during check, worm bearings are damaged. Steering gear should then be removed, disassembled, and bearings replaced as described later in this section under "Steering Gear Overhaul."

4. Remove top cover bolts and remove housing top cover (25). Remove as many shims from between top cover and housing as required to eliminate all worm end play, when cover is reinstalled and bolts fully tightened. Shims used are 0.002", 0.005", 0.010", and 0.030" thick. A minimum of three 0.002" thick and two 0.005" thick shims should be used.
5. Again check pull as in Step 3 above, and readjust, if necessary, to obtain proper pull. If adjustment is correct, adjust Pitman shaft lash as described in the following:

PITMAN SHAFT LASH ADJUSTMENT (Fig. 11)

NOTE: Worm bearing adjustment must be completed before making Pitman shaft lash adjustment.

1. Center steering gear by turning worm shaft from extreme right to extreme left position, counting exact number of turns; then rotate worm back exactly half-way. Mark worm yoke with Prussian blue to indicate center position.
2. Tighten side cover bolts (3) to torque listed in "Specifications." Turn lash adjuster screw (1) clockwise sufficiently to remove all lash between worm nut teeth and teeth on Pitman shaft sector. Amount of lash may be felt by pushing Pitman arm back and forth. When all lash has been removed, tighten lash adjuster lock nut (2) to torque listed in "Specifications."



1 Steering Wheel Nut	11 Sleeve
2 Washer	12 Bearing
3 Horn Button	13 Directional Switch Assembly
4 Retainer	14 Switch to Housing Screw
5 Cup	15 Steering Column Upper Jacket
6 Screw	16 Steering Wheel
7 Bushing	
8 Bellville Spring	
9 Cancelling Cam	
10 Spring	

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Figure 3—Steering Wheel and Horn Contact

Step 3 under "Worm Bearing Check and Adjustment," except measure greatest pull at CENTER position. If necessary, readjust to obtain pull within 2-3/4 to 3-1/4 pounds.

4. Connect drag link to Pitman shaft, adjusting drag link length, if necessary, as directed under "Drag Link" later in this section.

5. Connect propeller shaft universal joint yoke to yoke on worm shaft.

STEERING WHEEL REPLACEMENT

REMOVAL (Figs. 3 and 4)

Key numbers in text refer to figure 3.

1. Set front wheels in straight-ahead position.

2. Disconnect directional signal switch harness from chassis wiring harness connector. Refer to "Directional Signal Switch" in "LIGHTING SYSTEM" (SEC. 7) of this manual.

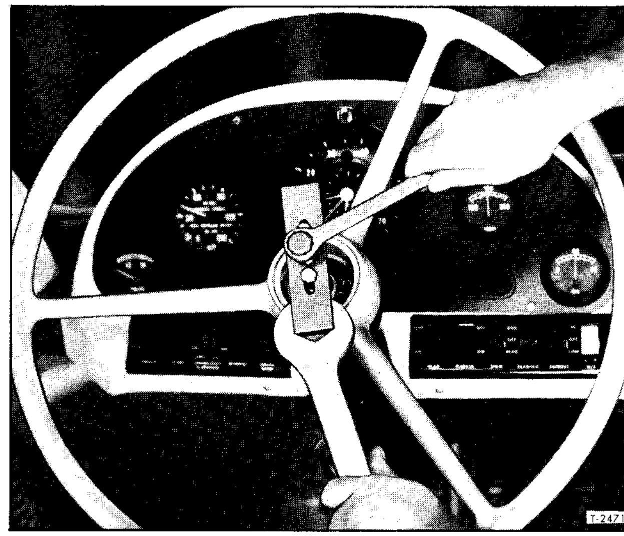


Figure 4—Removing Steering Wheel

3. Using a screwdriver, pry horn button (3) and retainer (4) from steering wheel.

4. Remove steering wheel nut (1) and washer (2) from steering column shaft.

5. Remove three screws (6) which attach cup (5), bushing (7) and Bellville spring (8) to steering wheel (16).

6. Lift contact assembly consisting of cup, cap, insulator, spring, and brush out of wheel.

7. Using steering wheel puller (J-2927-01) and two puller screws with 5/16-18 threads, pull steering wheel off shaft (fig. 4).

INSTALLATION (Fig. 3)

1. Position wheel on shaft.

2. Install contact assembly (cup, cap, insulator, spring, and brush) in steering wheel hub, making sure sleeve enters hole in cancelling cam.

3. Install Bellville spring, cup, and bushing and attach with three screws.

4. Install steering wheel washer and retaining nut on shaft. Tighten nut to torque listed in "Specifications" at end of this section.

5. Press horn button retainer and horn button into cup using soap water as lubricant on cup, and connect directional switch harness to chassis wiring harness connector.

STEERING COLUMN AND BEVEL GEAR

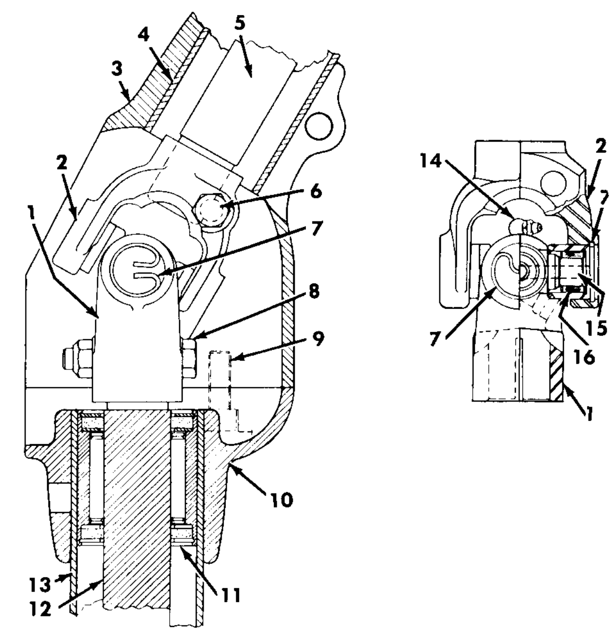
STEERING COLUMN REPLACEMENT

Whenever steering column and bevel gear assembly requires service which requires disassembly, the entire assembly can readily be removed from the coach.

REMOVAL (Fig. 1)

1. Disconnect directional switch harness from chassis wiring harness connector. Refer to "Directional Signal Switch" in "LIGHTING SYSTEM" (SEC. 7) of this manual.

2. Open door at left front corner of coach to



1 Lower End Yoke
2 Upper End Yoke
3 Upper Housing
4 Upper Column Jacket
5 Steering Column Upper Shaft
6 Universal Joint Upper Bolt
7 Snap Ring
8 Universal Joint Lower Bolt
9 Lower to Upper Housing Bolt
10 Lower Housing
11 Lower Column Upper Bearing
12 Steering Column Lower Shaft
13 Lower Column Jacket
14 Lubrication Fitting
15 Journal Assembly
16 Universal Joint Bearing

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Figure 5—Steering Column Universal Joint

gain access to steering lower column and bevel gear assembly.

3. Remove six metal screws attaching closure plates to coach floor. Remove closure plates.
4. Remove two lock nuts from steering column support U-bolt under coach floor. Remove U-bolt.
5. Lift latch and raise steering propeller shaft shield.
6. Remove clamp bolt securing universal joint yoke on bevel gear shaft. Slide universal joint assembly rearward until yoke is clear of shaft.
7. Remove nuts and washers from three bolts attaching bevel gear housing to mounting bracket on frame longitudinal member. NOTE: Heads of the mounting bolts are accessible through button plug openings inside tire carrier compartment.
8. Lift steering column and bevel gear assembly straight up and out of coach.

INSTALLATION (Fig. 1)

1. Insert steering column and bevel gear assembly downward through opening in coach floor.
2. Position bevel gear housing to mounting bracket and install three bolts, nuts, and washers. Do not tighten bolts.
3. Loosen two bolts attaching clamp plate to support; then tighten bevel gear housing to bracket attaching bolts.
4. Tighten the two clamp plate to support bolts, that were previously loosened in step 3.
5. Install steering column support U-bolt to clamp plate.
6. With Woodruff key in keyway in bevel gear shaft, install universal joint yoke on shaft. Install clamp bolt and tighten to torque listed in "Specifications." Lower steering propeller shaft shield and secure latch.
7. Position front and rear closure plates around steering column on coach floor; then install six metal screws attaching plates to floor.
8. Connect directional signal switch harness to chassis wiring harness connector.

STEERING COLUMN AND BEVEL GEAR OVERHAUL

(Refer to Figures 1, 2, 3 and 5)

DISASSEMBLY OF STEERING UPPER COLUMN

1. Remove steering wheel as previously described under "Steering Wheel Replacement."
2. Remove cancelling cam and coil spring from upper shaft.
3. Remove three screws which attach directional switch assembly to hub cover, and remove directional switch and housing.
4. Remove four cap screws attaching upper and lower universal joint housings. Lift upper column jacket and housing assembly from lower housing and upper shaft.
5. Remove two clamp bolts and lock nuts and remove steering column universal joint assembly from upper and lower steering column shafts.

DISASSEMBLY OF STEERING COLUMN UNIVERSAL JOINT (Fig. 5)

1. Remove four bearing retainer snap rings.
2. Using a soft hammer, drive journal assembly sideways and drive one bearing out of yoke.
3. Turn the assembly over and drive journal in opposite direction to remove second bearing from yoke. Separate end yokes.

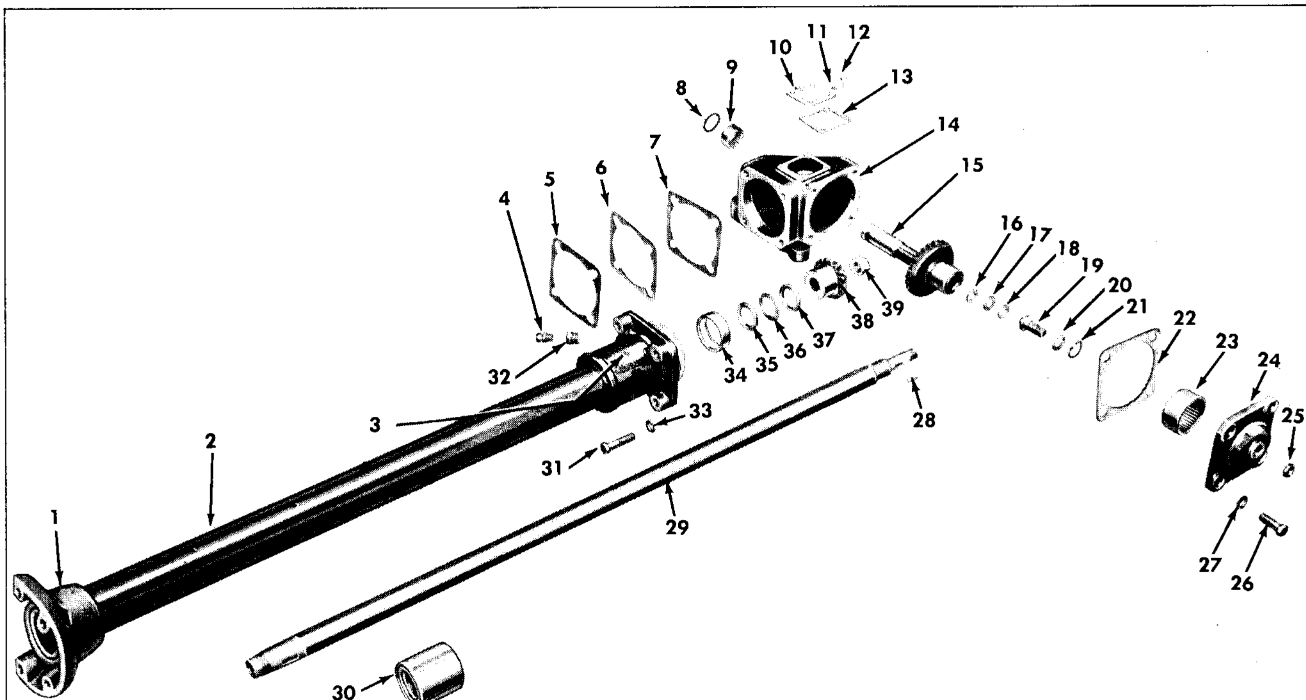
NOTE: Rollers will drop out of bearings. Use care to prevent damage to, or loss of bearing rollers.

4. Repeat procedures outlined in steps 2 and 3 above to remove two remaining bearings and journal assembly from end yoke.

DISASSEMBLY OF STEERING LOWER COLUMN AND BEVEL GEAR

Key numbers in text refer to figure 6.

1. Remove four bolts and lock washers attach-



1 Universal Joint Lower Cover
2 Steering Column Lower Jacket Assy. (Includes Items 1 & 3)
3 Bevel Gear Housing Upper Cover
4 Housing Vent
5 Thick Shim
6 Thin Shim
7 Thick Shim
8 Retainer
9 Bearing
10 Cover Plate
11 Lock Washer
12 Screw
13 Gasket
14 Bevel Gear Housing
15 Bevel Gear
16 Bearing Race
17 Bevel Gear Bearing
18 Bearing Race
19 Bevel Gear Adjusting Screw
20 Washer
21 Bearing Retainer Ring
22 Gasket
23 Housing Cap Bearing Assembly
24 Bevel Gear Housing Cap
25 Bevel Gear Nut
26 Cap to Housing Bolt
27 Lock Washer
28 Woodruff Key
29 Steering Column Lower Shaft
30 Lower Shaft Upper Bearing
31 Cover to Housing Bolt
32 Vent to Housing Bushing
33 Lock Washer
34 Housing Upper Cover Bearing Assembly
35 Bearing Race
36 Steering Shaft Lower Bearing
37 Bearing Race
38 Steering Shaft Pinion Gear
39 Pinion Gear to Shaft Nut T-2537

Figure 6—Lower Column and Bevel Gear Components

ing upper cover (3) to bevel gear housing (14). Lift jacket and cover assembly from bevel gear housing. Save shims (5, 6, and 7) used between cover and housing for reuse at assembly.

2. Remove steering shaft (29) from steering column jacket (2).

3. With a suitable puller and slide hammer, removing steering shaft upper bearing assembly as shown in figure 7.

4. With a suitable puller and slide hammer, remove the bearing assembly (34) from bevel gear upper cover (3). Refer to figure 8.

5. While holding steering shaft (29) in a vise with soft jaws, remove pinion gear retaining nut (39) from end of steering shaft (29).

6. Supporting the pinion gear, tap steering shaft (29) out of pinion gear(38) using a brass drift and hammer. Remove gear, lower bearing (36), and two bearing races (35 and 37).

7. Remove housing vent assembly (4) and reducing bushing (32) from upper cover (3).

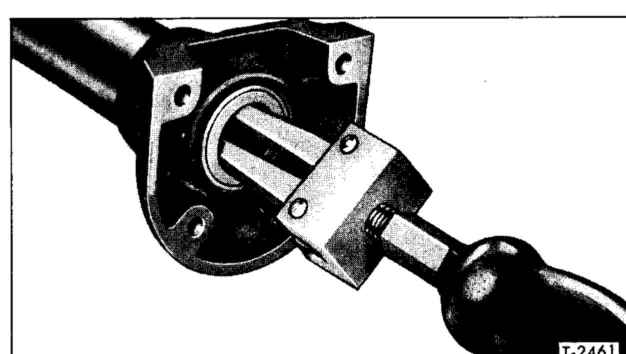


Figure 7—Removing Steering Shaft Upper Bearing

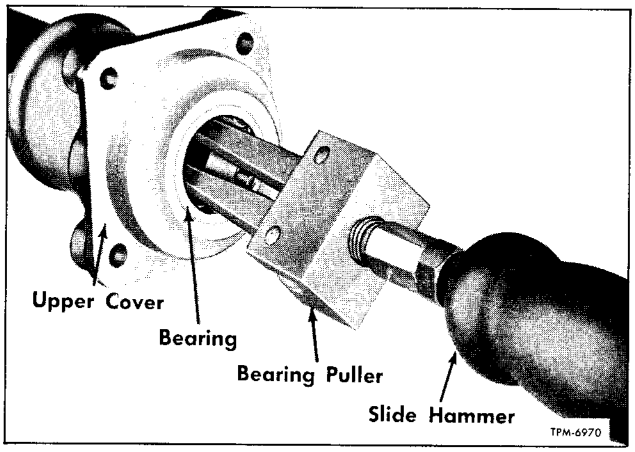


Figure 8—Removing Bearing From Upper Cover

8. Remove four bolts and lock washers, then remove housing cap (24) and bevel gear assembly (15) from bevel gear housing (14). Remove and discard gasket (22).

9. Remove lock nut (25); then using an Allen end wrench, thread adjusting screw (19) out of housing cap (24).

10. Remove snap ring (21) from bevel gear shaft (15).

11. Remove adjusting screw (19), washer (20), outer and inner race (16 and 18), and bearing (17) from bevel gear shaft (15).

12. Remove housing cap bearing race from large end of bevel gear (15) only if inspection shows necessity.

13. Using an arbor press and suitable remover tool, remove retainer seal (8) and bearing (9) from bevel gear housing (14).

14. Remove four screws (12) and lock washers, then remove cover plate (10) and gasket (13) from bevel gear housing (14). Discard gasket.

15. Remove drain plug from bevel gear housing (14).

16. Do not remove bearing (23) from housing cap (24) unless inspection shows necessity for removal.

CLEANING AND INSPECTION

Cleaning

Immerse all parts in cleaning solvent to loosen deposits of dirt or old lubricant. Repeat immersion and brushing with soft bristle brush until all parts are thoroughly clean. Remove any particles of old gasket remaining on bolting surfaces of housing.

Inspection

1. Inspect steering shafts and jackets for bent or twisted condition.

2. Examine bevel gear and pinion gear for worn, chipped, or broken teeth. Replace with new parts if defective.

3. Inspect all bearings for worn or damaged condition, such as flat spots on rollers, and damaged races. Replace with new parts if damaged.

4. Inspect housing cap bearing race on large end of bevel gear for wear or roughness. If damaged, split race with chisel and remove from gear.

5. Check universal joint needle bearings and journal for wear or damage. Pack bearing one-third full of grease to retain rollers, then install on journal to check fit on journal. If excessive clearance is evident, replace bearings or journal as necessary.

6. Always use new gaskets and snap rings when assembling the steering column and bevel gear assembly.

ASSEMBLY OF STEERING LOWER COLUMN AND BEVEL GEAR

Key numbers in text refer to figure 6.

1. Using an arbor press and suitable sleeve, press bearing assembly (23) into bore of bevel gear housing cap (24) if bearing was previously removed.

2. With press and suitable sleeve, press bearing assembly (9), and retainer seal (8) into bore of bevel gear housing (14).

3. Install drain plug in bore of bevel gear housing (14).

4. If bearing race was removed from bevel gear shaft (15) during inspection procedures, press new race on shaft. Race must be installed with stamped end out.

5. Position bevel gear in vise with soft jaws and install inner race (16), bearing (17), outer race (18), adjusting screw (19), washer (20), and snap ring (21) in bore of bevel gear shaft (15).

6. Position housing cap assembly (24) on end of bevel gear (15); then using an Allen end wrench, thread adjusting screw through cap. Install lock nut (25) on bevel gear adjusting screw (19) loosely. Nut is to be tightened later.

7. Place new gasket (22) over bevel gear (15) and against housing cap (24), then install bevel gear and cap assembly in bevel gear housing, attaching with four bolts and lock washers. Tighten to torque listed in "Specifications."

NOTE: Side of cap with corners cut off goes toward bottom of housing.

8. Install Woodruff key (28) in slot in lower end of steering shaft (29).

9. With suitable sleeve and hammer, tap bearing assembly (34) into housing upper cover (3).

10. Insert steering shaft (29) through top of column jacket (2) and install bearing race (35), bearing (36), and second race (37) over steering

shaft and into bore of housing upper cover.

11. Using a plastic hammer, tap steering shaft pinion gear (38) on lower end of steering shaft. Install retaining nut (39) on shaft. Tighten nut to torque listed in "Specifications."

12. Install reducing bushing (32) and vent assembly (4) in housing upper cover (3).

13. Press or tap upper bearing assembly (30) into lower steering column jacket.

14. Position original shims (5, 6, and 7) on housing upper cover.

NOTE: Approximately two thick shims and one thin shim are required to maintain proper adjustment. Thin shims must be placed between thick shims. Shims are 0.003" and 0.010" thick.

15. To adjust backlash, remove or add shims between housing and upper cover. Removing shims will decrease backlash, while adding shims will increase backlash. Proper adjustment provides for smooth rotation of gears without binding and a minimum of backlash.

16. Install bevel gear housing assembly on lower steering column and upper cover assembly, attaching with four bolts and lock washers. Tighten bolts to torque listed in "Specifications."

17. Check backlash of bevel gears. Maximum allowable backlash to 0.002". Revolve gears to make sure there is no perceptible bind at any point. If gears are meshed too tight, hard steering will result. If gears are too loose, operation will be rough and noisy with excessive steering wheel play. To adjust gear lash, thread bevel gear adjuster screw (19), in or out as necessary to obtain proper gear lash; tighten lock nut (25) securely.

18. Install new gasket (13) and cover plate (10) on bevel gear housing, attaching with four screws and lock washers. Tighten screws firmly.

ASSEMBLY OF STEERING COLUMN UNIVERSAL JOINT (Fig. 5)

1. Position journal arms in one of the end yokes; then press a bearing assembly on journal arm. Install snap ring to retain bearing.

2. Repeat step one to install bearing assembly on opposite journal arm.

3. Position journal arms in the retaining end yoke and repeat steps 1 and 2 to install remaining bearings and snap rings.

ASSEMBLY OF STEERING UPPER COLUMN

Refer to figures 1, 2, and 3.

1. Install Woodruff keys in slot of upper end of lower shaft and lower end of upper shaft.

2. Position steering column universal joint on upper and lower steering shafts.

3. Install clamp bolts and lock nuts. Tighten to torque listed in "Specifications."

4. Lubricate steering column universal joint as described in LUBRICATION (SEC. 13).

5. Position upper steering column on lower column and bevel gear assembly; then install four attaching cap screws. Tighten to torque listed in "Specifications."

6. Check distance from top of upper jacket to shoulder on upper shaft. If not 1.87" as shown in figure 6, loosen clamp bolt in universal joint upper housing and adjust jacket in housing to obtain correct dimension. Tighten clamp bolt to torque listed in "Specifications."

7. Install directional switch and housing on steering column shaft and attach to hub cover with three screws.

8. Install coil spring and cancelling cam on steering shaft.

9. Install steering wheel and horn parts as previously described under "Steering Wheel Replacement."

STEERING PROPELLER SHAFTS

REPLACEMENT

Steering propeller shafts and center bearing support assembly, which transmit motion between steering column bevel gear and steering gear, are illustrated in figure 1. Propeller shafts (fig. 9) are tubular type equipped with needle bearing type universal joints at each end, also a splined slip joint to absorb endwise movement. Center bearing support assembly (fig. 10) is supported by a bracket riveted into body understructure.

REMOVAL

Front Propeller Shaft

1. Remove lock nuts and U-bolts attaching front propeller shaft to yoke on center bearing support. Remove shaft from support.

2. Remove clamp bolt and lock nut attaching front propeller shaft end yoke to steering column bevel gear shaft.

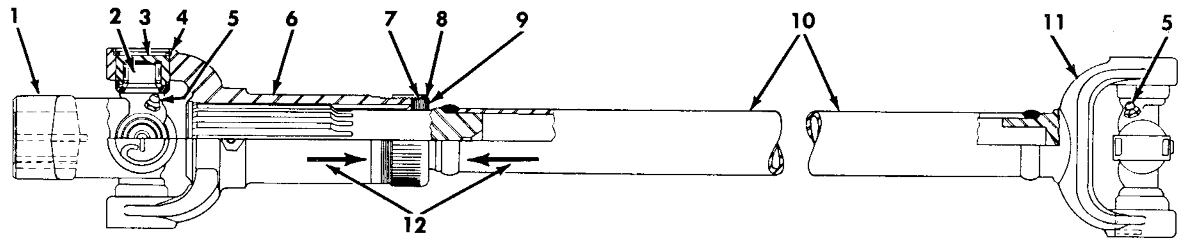
3. Tap propeller shaft yoke off bevel gear shaft with a soft hammer. Remove propeller shaft.

Rear Propeller Shaft

1. Remove lock nuts and U-bolts attaching rear propeller shaft to end yoke on center bearing support.

2. Remove lock nuts and U-bolts attaching rear propeller shaft to end yoke on steering gear worm shaft.

MECHANICAL STEERING



1 End Yoke
2 Journal Cross
3 Bearing
4 Snap Ring
5 Lubrication Fitting
6 Slip Joint Sleeve Yoke
7 Cork Washer
8 Steel Washer
9 Dust Cap
10 Propeller Shaft Tube
11 Fixed Joint
12 Arrows Must Be In Line - They Align Trunnions

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Figure 9—Steering Propeller Shaft (Front Shaft Shown)

INSTALLATION

Front Propeller Shaft

1. Position front propeller shaft end yoke against yoke on center bearing support.

NOTE: Slip joint end of shaft goes toward front of coach.

2. Install attaching U-bolts and lock nuts. Tighten nuts to torque listed in "Specifications."
3. Make sure Woodruff key is properly installed in slot of bevel gear shaft. Position propeller shaft and yoke on bevel gear shaft.
4. Install clamp bolt and lock nut. Tighten nut to torque listed in "Specifications."

Rear Propeller Shaft

1. Position rear propeller shaft end yoke to yoke on center bearing support.

NOTE: Slip joint end of shaft goes toward front of coach.

2. Install attaching U-bolts and lock nuts. Tighten nuts to torque listed in "Specifications."
3. Position end yoke on opposite end of shaft against end yoke on steering gear worm shaft.
4. Install attaching U-bolts and lock nuts. Tighten lock nuts to torque listed in "Specifications."

STEERING PROPELLER SHAFT OVERHAUL

DISASSEMBLY

Key numbers in text refer to figure 9.

NOTE: Overhaul procedures for the front and rear steering propeller shafts are the same for both shafts. Boot must be removed from slip joint end of rear shaft.

1. Before disassembling the propeller shaft, look for alignment arrows (12) on shaft and slip joint sleeve. If arrows are not readily discernible, mark both parts so they can be reassembled in exactly the same positions.
2. Unscrew dust cap (9) from slip joint sleeve and pull slip joint assembly (6) off shaft (10). Remove steel washer (8) and cork washer (7) from dust cap (9).

NOTE: Succeeding procedures cover disassembly of universal joint at either slip joint or fixed end of shaft.

3. Remove snap rings (4) retaining bearings in end yokes.
4. Using a soft hammer, tap journal cross (2) sideways and push one bearing (3) out of yoke.
5. Turn shaft over and drive journal (2) in opposite direction to remove the second bearing. Repeat these procedures to remove remaining bearings. Remove journals from yokes.

NOTE: Rollers will drop out of bearings. Use care to prevent loss of or damage to rollers.

CLEANING AND INSPECTION

1. Clean all parts in suitable cleaning solvent. Make sure lubricant passages in journals are clean. Soak needle bearing assemblies in cleaning solvent to loosen old lubricant. Clean parts with stiff bristled brush and blow dry with compressed air.
2. Inspect bearing surfaces of journals for roughness. If journals will not clean up with moderate honing, journal should be replaced. When new journal is used, new bearings should also be used. Carefully inspect each bearing assembly for damage or missing rollers. Excessive wear is indicated if rollers drop out of retainer, or if journal bearing surfaces show marks of rollers.
3. After bearings are clean, pack with lubricant recommended in LUBRICATION (SEC. 13) of this manual. Place bearings on journal and check for wear (looseness). If excessive clearance is indicated, replace journal or bearings, or both.

ASSEMBLY

1. Install lubrication fittings (5) if previously removed.

2. Insert one end of a journal into yoke as far as possible from inside; then tilt journal until opposite side of journal will drop into other side of yoke. Install journal in other yoke in same manner.

3. Install bearings (3) in yokes over ends of journal, tapping bearings into place with a rawhide or plastic hammer if necessary. Install new snap rings (4) to secure bearings in yokes. Make sure snap rings are fully seated in grooves.

4. Repeat these procedures to install journal and bearing at opposite end of shaft.

5. Install steel washer (8) and new cork washer (7) in dust cap (9) on slip joint end of shaft.

6. Insert shaft (10) into slip joint sleeve, being sure arrows (12) or marks made prior to disassembly are aligned. Thread dust cap onto slip joint sleeve and tighten with hand.

7. Wrap boot around slip joint of rear shaft and lace securely in place.

STEERING PROPELLER SHAFT SUPPORT

Front and rear steering propeller shafts are connected and supported by the center bearing support assembly which is attached to coach understructure (fig. 10).

DISASSEMBLY

1. Disconnect rear end of front propeller shaft and front end of rear propeller shaft as directed previously in this section.

2. Remove yoke retaining screw (5), lock washer (4), and flat washer (3) from either yoke. Use suitable puller to pull yoke (6) and seal assembly (2) from stub shaft (9).

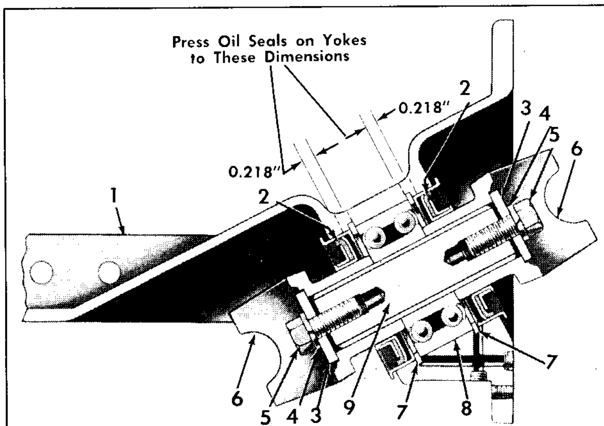
3. Push stub shaft (9) and remaining yoke assembly out of support and bearing. Mount stub shaft (9) in vise having soft jaw plates and remove remaining yoke screw and washers; then pull yoke from shaft.

4. Press oil seal assembly (2) from each yoke. Remove two bearing retainers (7) from support; then remove bearing (8).

CLEANING AND INSPECTION

1. Immerse all parts in suitable cleaning solvent to loosen and remove all deposits and accumulations of dirt and old lubricant. Remove lubrication fitting and pipe plug from support; then clean lubricant passages and inside of support.

2. Rotate the bearing assembly slowly while examining for rough balls, flat spots, chips, or other damage. Replace bearing if not in good condition.



1 Support
2 Oil Seal Assembly
3 Flat Washer
4 Lock Washer
5 Retaining Bolt
6 End Yoke
7 Bearing Retainer
8 Bearing Assembly
9 Stub Shaft

Figure 10—Steering Propeller Shaft Support

3. After the bearing has been cleaned and inspected, lubricate bearing and wrap in a clean cloth until ready for installation.

4. Replace all parts that are not in good condition.

ASSEMBLY

1. Install one bearing retainer (7) into groove in propeller shaft center bearing support (1).

2. Install bearing (8) in support; then install opposite bearing retainer (7). Carefully check both bearing retainers to be sure they are fully seated in their grooves.

3. Press new oil seal (2) assembly onto each end yoke (6) to dimension shown in figure 10.

4. Install one yoke and seal assembly onto stub shaft (9) and secure with flat washer (3), lock washer (4), and retaining bolt (5).

5. Apply a liberal coating of grease to lip of oil seals. Install stub shaft (9) and yoke assembly into support and bearing; then install remaining yoke and oil seal assembly. Install yoke retaining flat washer, lock washer, and retaining bolt; then tighten both yoke retaining bolts (7).

6. Install lubrication fitting in support and apply lubricant recommended in LUBRICATION (SEC-13) until it appears at lip of seal, indicating that bearing is thoroughly lubricated.

7. Connect front and rear steering propeller shafts to center bearing support yokes as directed previously in this section.

STEERING GEAR

STEERING GEAR REPLACEMENT

REMOVAL (Fig. 1)

1. Disconnect propeller shaft universal joint yoke from yoke on steering gear worm shaft.
2. Disconnect the drag link from Pitman arm; then remove Pitman arm retaining nut and lock washer. Pull Pitman arm off shaft, using puller (J-3186) or other suitable puller.
3. Remove forward nut and lock washer from right-hand support U-bolt. Remove nuts and lock washers from two left-hand support studs. Remove two bolts and lock washers located in gear housing flange at forward side of the axle center.
4. Lift steering gear assembly up off studs and move forward off axle.

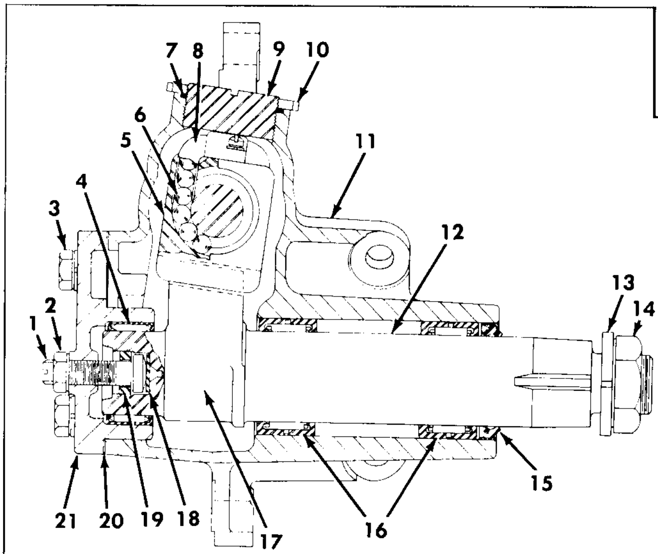
INSTALLATION (Fig. 1)

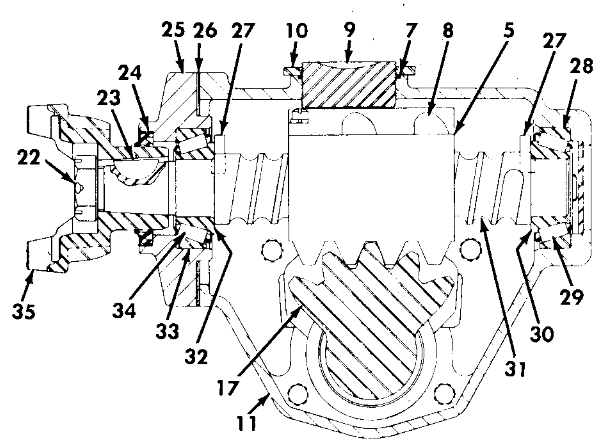
1. Position steering gear assembly on front axle, with two left-hand support studs and front end of right-hand support U-bolt engaging holes in steering gear housing flanges.
2. Install nuts and lock washers on studs and U-bolt. Install two gear housing to axle bolts in gear housing flange at front side of axle. Tighten to torque listed in "Specifications."
3. With front wheels in straight-ahead position, install Pitman arm on Pitman shaft so centerline of hole at drag link end of arm is to right of centerline of coach when gear is centered.

NOTE: Centerline of coach can be identified by prick punch marks on rear side of front axle.

Steering gear can be centered by turning worm shaft from extreme right to extreme left position, counting exact number of turns; then rotate worm shaft back exactly half way.

4. Install lock washer and nut on Pitman shaft. Tighten nut to torque listed in "Specifications."
5. Position end stud on drag link in hole in Pitman arm; then install stud nut and new cotter pin. Tighten nut firmly.
6. Connect propeller shaft universal joint yoke to yoke on steering gear worm, using two U-bolts





1 Lash Adjuster Screw
2 Lock Nut
3 Side Cover Bolt
4 Pitman Shaft Side Cover Bearing
5 Worm Ball Nut
6 Worm Balls
7 Back-up Adjuster Packing
8 Ball Guide
9 Back-up Adjuster
10 Back-up Adjuster Lock Nut
11 Steering Gear Housing
12 Pitman Shaft
13 Lock Washer
14 Pitman Arm Nut
15 Pitman Shaft Oil Seal
16 Pitman Shaft Housing Bearings
17 Pitman Shaft Sector Gear
18 Lash Adjuster Thrust Washer
19 Lash Adjuster Retainer
20 Side Cover Gasket
21 Housing Side Cover
22 End Yoke Nut
23 End Yoke Key
24 Steering Shaft Oil Seal
25 Housing Upper Cover
26 Bearing Adjusting Shims
27 Ball Nut Stops
28 Worm Bearing Cup - Lower
29 Worm Bearing - Lower
30 Worm Bearing Cone - Lower
31 Steering Shaft Worm
32 Worm Bearing Cone - Upper
33 Worm Bearing Cup - Upper
34 Worm Bearing - Upper
35 Steering Shaft End Yoke

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Figure 11—Mechanical Steering Gear Assembly

and lock nuts.

7. Lubricate all points in steering system as instructed in LUBRICATION (SEC. 13).

STEERING GEAR OVERHAUL

(Key Numbers in Text Refer to Figure 11)

DISASSEMBLY

The steering gear parts must be kept free from dirt or other foreign matter during overhaul procedures.

1. Remove steering gear as directed previously in this section.

2. Remove plugs and drain as much lubricant as possible from the housing.

3. Mount steering gear assembly in a vise or holding fixture with the worm shaft horizontal. Do not grip the housing too tightly in vise.

4. Loosen lock nut (10); then remove back-up adjuster (9), packing, and lock nut. Discard packing.

5. Remove vent assembly from housing. Remove cotter pin and nut (22) attaching propeller shaft yoke (35) to steering gear worm (31); pull yoke off worm.

6. Remove lock nut (2) from lash adjuster screw (1). Remove four bolts (3) and lock washers attaching side cover (21) to housing. Remove side cover and bearing assembly (4), using a screwdriver to thread lash adjuster screw out of cover as cover is withdrawn. Remove and discard side cover gasket (20).

7. Make sure the worm shaft (31) is horizontal and rotate shaft as necessary to position sector gear (17) on Pitman shaft (12) so it will pass through opening in gear housing; then withdraw Pitman shaft (12) from gear housing.

NOTE: Horizontal position of the worm shaft is necessary to prevent ball nut (5) from running down to end of worm as Pitman shaft (12) is withdrawn, thereby damaging the ball return guides.

8. Remove four bolts and lock washers attaching top cover (25) to housing (11); then carefully withdraw top cover, worm, and ball nut assembly as a unit. Remove lower worm thrust bearing (29).

9. Remove top cover (25) from worm shaft (31). Remove upper thrust bearing (34) from top cover (25). Retain shim pack (26) for reassembly of steering gear.

IMPORTANT: Do not hold worm shaft (31) in a vertical position as ball nut (5) will travel by its own weight to end of shaft. If ball nut sharply strikes either end of shaft worm, ball guides (8) will be damaged.

10. Try action of ball nut (5) on shaft worm (31). Ball nut must rotate smoothly with no evidence of binding or roughness. Tape shaft worm at both ends of ball nut to keep nut from running up or down; then lay the assembly flat on work bench until ready to disassemble.

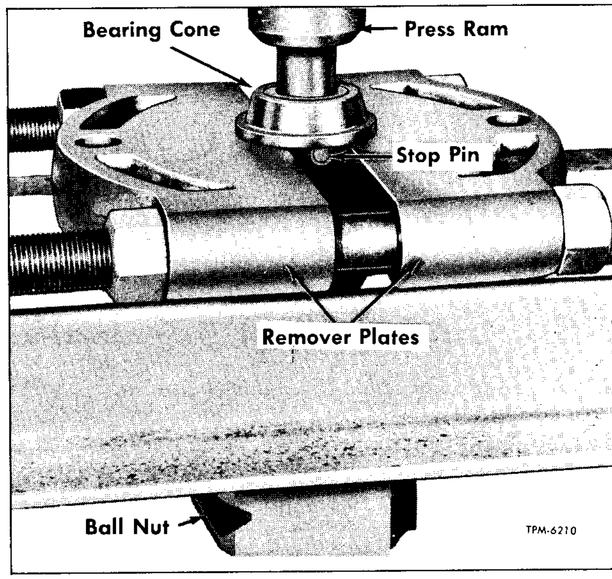


Figure 12—Removing Lower Worm Thrust Bearing Cone

11. Remove lower thrust bearing cone (30) from worm shaft (31), using bearing remover plates (J-8176) (fig. 12).

12. Remove lower ball nut pin stop (27).

13. Remove screws attaching ball guide clamp to ball nut (5). Remove clamp. Pull ball guides out of ball nut as shown in figure 13. Remove balls (6) from guides by separating guides.

14. Remove tape from shaft worm; then turn ball nut upside down over a clean pan and rotate worm shaft back and forth until all balls have been removed. Pull ball nut endwise from worm shaft.

15. Remove upper thrust bearing cone (32) from worm shaft (31), using bearing remover plates (J-8176). Refer to figure 12. Remove upper ball nut stop pin (27) from worm shaft.

16. Remove Pitman shaft oil seal (15) from gear housing (11) and discard.

17. Remove worm shaft oil seal (24) from top cover (25) and discard. New oil seals should be used when reassembling the steering gear.

18. Removal of lower worm thrust bearing

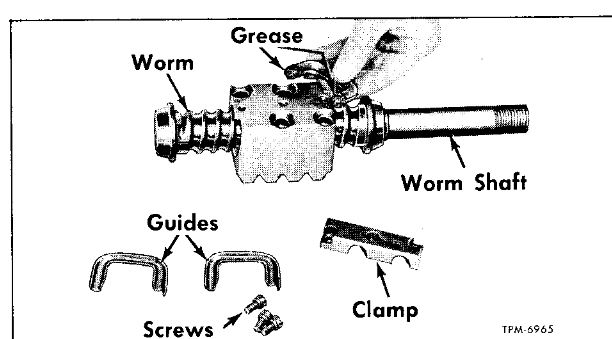


Figure 13—Ball Guide Removal and Installation (Typical)

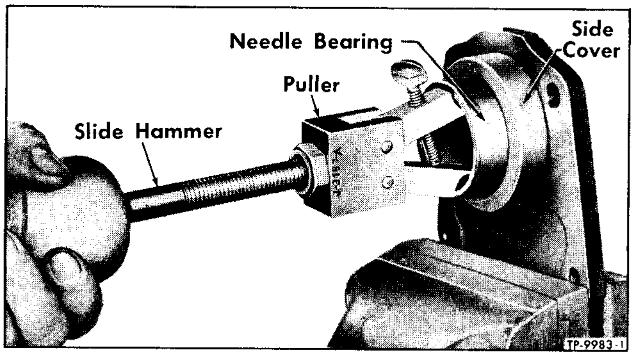


Figure 14—Removing Side Cover Needle Bearing (Typical)

cup (28) from housing, upper thrust bearing cup (33) from top cover, needle bearing (4) from side cover, and needle bearings (16) from housing should be deferred until inspection of parts indicate necessity for further disassembly.

CLEANING AND INSPECTION

1. Wash all parts thoroughly in suitable cleaning solvent and wipe or blow parts dry prior to inspection, repair, and reassembly of the steering gear. Procedure should not be attempted in dirty surroundings. Parts must be absolutely clean.
2. Inspect steering gear housing and side cover for cracks, distortion, and condition of threads in tapped holes. Replace parts if damaged.
3. Examine needle roller bearings in housing and side cover for cracked, chipped, or worn rollers. If worn or damaged, bearing assemblies must be replaced as directed later under "Pitman Shaft Bearing Replacement."

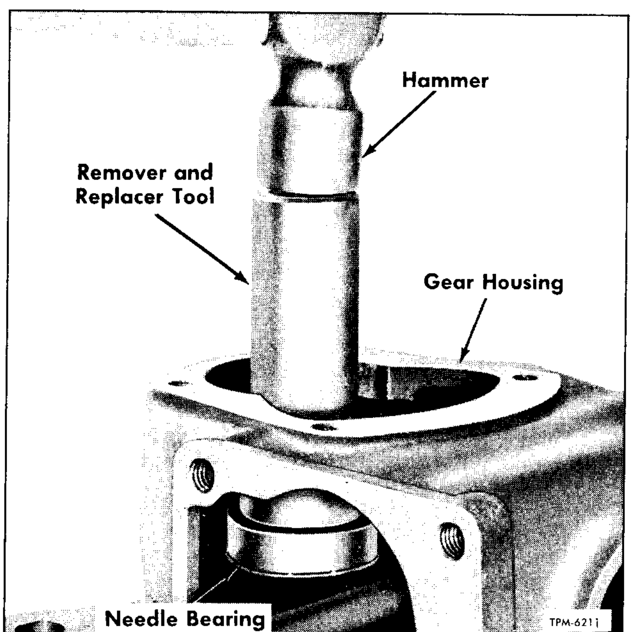


Figure 15—Removing or Installing Needle Bearing in Housing (Typical)

4. Inspect Pitman shaft sector teeth and mating worm nut teeth for wear or damage. Check Pitman shaft for wear at bearing surfaces. If excessive wear is evident, replace shaft. Check condition of threads on lash adjuster screw, and check amount of screw end play in shaft. Any damage will necessitate replacement of lash adjuster screw; however, if screw is only loose (more than 0.005" end play), an adjustment may be made. Replacement and adjustment instructions are given later under "Lash Adjuster Replacement and Adjustment."
5. Inspect worm tapered roller bearing assemblies for worn or damaged rollers; also inspect bearing cups in top cover and housing and upper and lower bearing cones for wear or damage. If either the bearing rollers, cups, or cones are damaged, replace with complete new bearing assemblies. Instructions for replacing bearing cups are given later under "Worm Thrust Bearing Cup Replacement."
6. Inspect steering worm shaft for scoring, distortion, or wear.
7. Examine ball nut for scuffing, scoring, or wear on rack teeth and on ball thread groove. Check all holes and passages for obstructions. Check worm ball for flat spots, checking, wear, or damage. Balls should all be the same size within 0.0001".
8. Check expansion plug in housing for looseness or signs of grease leakage. If apparent, replace plug as follows:
   a. Remove plug from housing by pressing center of plug outward from housing. As curvature of plug is changed, it will become loose and can easily be removed without damage to housing.
   b. While expansion plug is removed, check condition of lower worm thrust bearing cup. Replace if necessary, as described later under "Worm Thrust Bearing Cup Replacement."
   c. Position new expansion plug in gear housing with convex side facing out. Press on center of plug to deform it inward to secure in housing.
9. Inspect ball return guides for distortion or damage. Place two halves of a guide together and try action of balls in guide. Replace guides if any restriction exists. Check return guide clamp.
10. Check end cover for cracks or damage.

STEERING GEAR REPAIR

PITMAN SHAFT BEARING REPLACEMENT (Fig. 11)

When inspection indicates the need of replacing Pitman shaft needle roller bearings (4 and 16) in housing and side cover, it is recommended that suitable tools be used to remove and replace bearings to avoid damage to the bearings and steering

gear housing.

1. Pull needle bearing from side cover, using puller tool (J-3187-A) with slide hammer (J-2619) (fig. 14).

2. Press or drive needle bearings from steering gear housing, using remover and replacer tool (J-5529) (fig. 15).

3. Install bearings in both side cover and gear housing with remover and replacer tool (J-5529). During installation, press only against the stamped identification side of bearing. Press side cover bearing in flush with face of side cover.

WORM THRUST BEARING CUP REPLACEMENT

1. Using a suitable punch and hammer, drive bearing cup (28) from steering gear housing.

2. Position new bearing cup squarely over recess in gear housing and press cup in until it is firmly and evenly seated. Use old cup to press new cup into place.

3. Repeat these procedures for top cover bearing cup (33) replacement.

LASH ADJUSTER REPLACEMENT AND ADJUSTMENT

1. Lash adjuster retainer is tack-welded in end of Pitman shaft (fig. 16). Break tack-weld and withdraw retainer from shaft. Remove adjuster screw and thrust washer.

2. Install a new thrust washer and adjuster screw, lubricating end of adjuster screw with recommended steering gear lubricant.

3. Screw retainer in tight; then back off 30 degrees to obtain correct adjustment. Tack-weld retainer at points shown in figure 16.

ASSEMBLY OF STEERING GEAR

GENERAL

One of the most important phases when assembling the steering gear is cleanliness. All parts must be kept clean. Any bits of abrasive material which may get inside the housing during assembly procedures will quickly damage the gear mechanism. Grease and oil used at assembly must be free from dirt. When handling parts, make certain that hands are clean and that clean cloths are used. Pre-lubricate all bearings, oil seals, and moving parts at assembly with proper lubricant specified in LUBRICATION (SEC. 13) of this manual.

ASSEMBLING BALL NUT AND WORM

1. Install worm ball nut over shaft worm with return guide holes in ball nut up. Align grooves in worm and ball nut by sighting through bottom of ball return guide holes.

2. Divide total number of balls into two clean containers (42 balls for each circuit).

3. Drop balls into one of the return guide holes in upper circuit of nut. Gradually turn shaft away from that hole while inserting balls. Continue until the circuit is filled from bottom of one hole to bottom of the other, or until stopped by reaching end of the shaft worm (fig. 17).

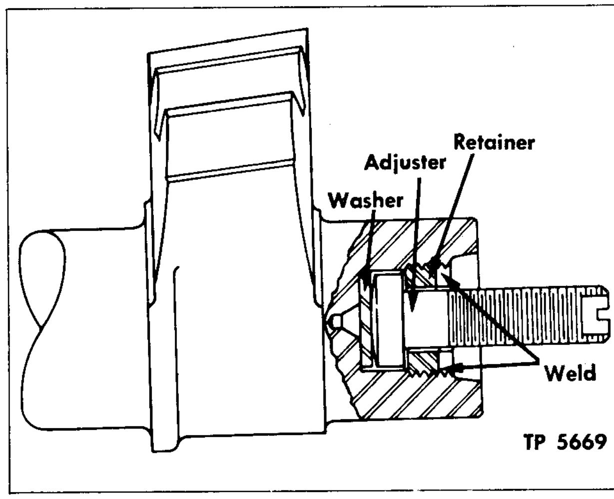


Figure 16—Lash Adjuster Screw Installation

4. In event balls are stopped by reaching end of shaft worm, hold down balls already installed with a rod or punch in return guide hole (fig. 17). Turn shaft in the reverse direction a few turns. Filling of the circuit can then be continued. It may be necessary to work shaft back and forth, holding balls down, first in one hole and then in the other. This will close up spaces between balls, filling the circuit completely and solidly.

5. Lay one-half of a ball guide on bench with groove up. Place the remaining balls for the first circuit into groove of the guide (fig. 18). Close this half of ball guide with other half. Hold the two halves together and plug each open end with heavy grease to prevent balls from dropping out.

6. Push ball return guides, with balls, completely into return holes in ball nut. Tap guide lightly with screwdriver handle to seat if neces-

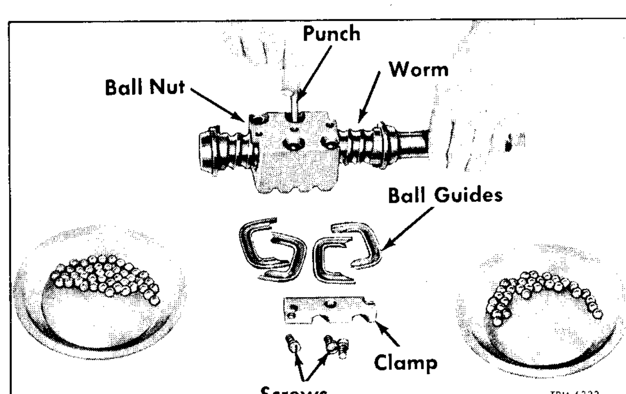


Figure 17—Filling Ball Circuits in Nut (Typical)

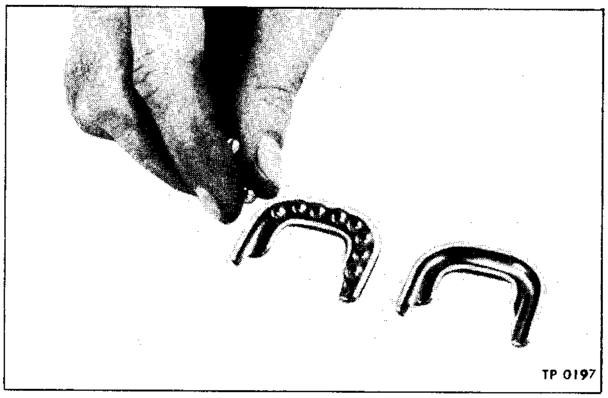


Figure 18—Filling Ball Guides

sary. This completes one circuit of balls.

7. Fill lower ball circuit in ball nut in same manner as described for upper ball circuit.

8. Install ball return guide clamp on ball nut, using the three screw and lock washer assemblies. Tighten screws securely.

9. Thoroughly lubricate ball nut and balls; then test assembly by rotating ball nut on shaft worm. Do not rotate ball nut to end of worm threads as this may damage ball guides. If motion of worm nut is not free, cause of bind must be located and trouble corrected. Bent ball guides may restrict ball circuit travel.

10. Temporarily tape shaft worm at both ends of ball nut to keep nut from running up or down; then until ready to install in gear housing, lay the assembly flat on work bench.

INSTALLATION OF WORM, BALL NUT, AND TOP COVER ASSEMBLY

1. Lubricate new worm oil seal (24) and press in base of top cover. Seal should be positioned so that lip of seal faces toward steering gear housing.

2. Install ball nut upper stop pin (27) in worm shaft slot.

3. Press upper thrust bearing cone (32) on worm shaft, using bearing installer plates (J-8176).

4. Install ball nut lower stop pin (27) in slot in worm shaft.

5. Press lower thrust bearing cone (30) on worm shaft, using bearing installer plates (J-8176).

6. Mount steering gear housing in holding fixture or vise so that top cover opening is up. Do not grip too tightly.

7. Lubricate worm thrust roller bearing (29) and position in cup (28) in lower end of gear housing.

8. Place original pack of shims (26) on top cover (25). Shims are available in 0.002", 0.005", 0.010", and 0.030" thickness. A minimum of three 0.002" and two 0.005" shims must be used for initial adjustment.

9. Lubricate upper worm thrust bearing (34); then position bearing on upper end of worm shaft over upper cone (32). Place top cover (25) over shaft and on bearing.

10. Remove tape from shaft worm at both ends of the ball nut; then gently rotate ball nut assembly so that it contacts stop pin (27) in lower end of the worm.

11. Lift top cover, worm, and ball nut assembly by grasping top cover and worm. Turn the shaft into a vertical position so that ball nut is on the bottom. Carefully guide the assembly into gear housing until bearing cone (30) on worm shaft contacts lower worm thrust bearing (29). In so doing, rotate the worm so ball nut return guide clamp faces the back-up adjuster opening in the housing. Bolt top cover to gear housing. Tighten bolts to torque listed in "Specifications."

12. Accomplish all procedures described in steps 1 through 10 under "Installation of Pitman Shaft and Side Cover" following:

INSTALLATION OF PITMAN SHAFT AND SIDE COVER

1. With gear housing positioned in vise or holding fixture so that worm shaft (31) is horizontal, proceed as follows:

2. While holding worm nut (5), turn worm shaft to move nut to center of worm. This is necessary so that worm nut and Pitman shaft will mesh properly when the shaft is installed. Center tooth on Pitman shaft sector (17) must enter center space in worm nut (5).

3. Apply proper lubricant to shaft bearings (16) in gear housing. Position Pitman shaft in gear housing, being careful not to damage bearings with serrated end of the shaft.

4. Position a new gasket (20) on gear housing side cover opening.

5. Apply proper lubricant to side cover bearing (4). Place side cover on lash adjuster screw (1) in Pitman shaft. With screwdriver through hole in side cover, thread lash adjuster screw through cover until cover is pulled against housing. Back off lash adjuster screw a few additional turns to provide backlash between sector gear (17) on shaft and ball nut (5).

6. Install side cover to housing with attaching bolts (3) and lock washers. Tighten bolts to torque listed in "Specifications." Install adjuster screw lock nut (2) loosely.

7. Install new Pitman shaft oil seal (15) carefully over Pitman shaft so that serrations on shaft do not damage seal. Lips of oil seal should face inside of gear housing. Be sure oil seal is well seated in housing. Tool used to install bearing in housing may be used to install oil seals.

8. Install back-up adjuster, new packing, and lock nut loosely in the gear housing. Do not make adjustment until all other adjustments have been made.

9. Tap Woodruff key (23) into key slot in worm shaft and install propeller shaft yoke (35). Secure yoke on worm shaft with nut and cotter pin.

10. Install bushing and lubrication fitting in tapped boss in bottom of gear housing. Fill gear housing with proper lubricant as described in LUBRICATION (SEC. 13) of this manual.

11. Install the steering gear assembly in coach as described earlier in this section under "Steering Gear Replacement."

12. Adjust worm bearings, and make Pitman shaft lash adjustment as previously directed in this section under "Steering Gear Adjustments."

13. Tighten back-up adjuster (9) until adjuster bottoms against ball nut return guide clamp. Back off adjuster 1/4 turn and secure in place with adjuster lock nut. Tighten lock nut to 30-50 foot-pounds torque. Purpose of the back-up adjuster is to keep the worm shaft from flexing up and down.

STEERING DRAG LINK

DESCRIPTION

Steering drag link assembly is a three-piece type, comprised of drag link tube and two socket end assemblies. As shown in figure 19, drag link ends are roller bearing type and incorporate an adjustment feature which automatically compensates for wear on bearing surfaces. Both end assemblies are identical, except that end assembly at steering arm screws onto drag link to provide for length adjustment, while end at Pitman arm is integral with drag link tube. Drag link end at steering arm is retained on drag link with clamp bolts.

MAINTENANCE

Linkage between steering gear and front axle definitely affects steering action if parts are out of adjustment, bent, or twisted. Check steering geometry and front wheel alignment as directed in FRONT AXLE (SEC. 1) when steering linkage is repaired or replaced.

Drag link end stud nuts must be kept tight or stud holes in steering arm and Pitman arm may become enlarged as a result of excessive looseness. Subsequent tightening of stud nuts may draw studs into arms so far that dust cover parts may be damaged during sharp turns.

Drag link ends are equipped with lubrication fittings and should be lubricated as directed in LUBRICATION (SEC. 13).

LENGTH ADJUSTMENT

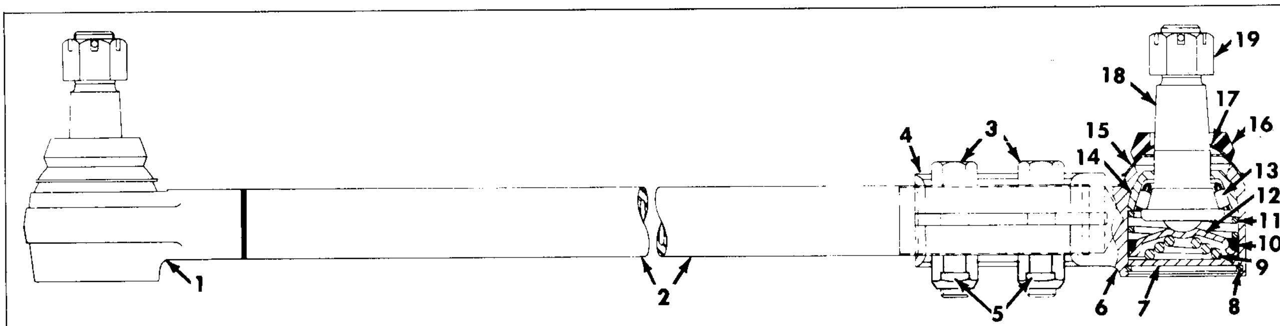
It should not be necessary to alter length of drag link except when new link is installed or when removable end has been removed for overhaul. If necessary to adjust drag link length, proceed as follows:

1. Position front wheels in straight-ahead position.

2. Remove drag link ends from Pitman arm and steering arm.

3. Locate center of steering movement by turning steering wheel from extreme right to extreme left, counting the number of turns, then back up exactly half way.

4. Check position of Pitman arm. Refer to "FRONT END ALIGNMENT" (SEC. 1) of this manual.



1 End Socket
2 Drag Link Tube
3 Socket Clamp·Bolt
4 Clamp
5 Lock Nuts
6 End Socket
7 Plug
8 Plug Lock
9 Seat Spring
10 Grease Retainer
11 Socket Centering Spring
12 Stud Seat
13 Stud Bearing
14 Bearing Race
15 Inner Dust Cover Washer
16 Dust Seal
17 Outer Dust Cover Washer
18 End Stud
19 Stud Nut

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Figure 19—Drag Link Assembly

MECHANICAL STEERING

5. Connect fixed drag link end to Pitman arm.

6. Stud at adjustable end of drag link should fit in steering arm without changing position of Pitman arm or front wheels.

7. If parts do not assemble correctly, first check all linkage for bends or distortion. If none of the drag link parts are found to be bent or twisted, loosen clamp bolts; then turn drag link end enough to obtain length to permit installation of end stud in steering arm without twist or bind.

8. Tighten clamp bolts firmly; then test adjustment. Front wheels should turn from right to left extremes without noticeable binding at drag link ends.

REMOVAL AND DISASSEMBLY

Key numbers in text refer to figure 19.

Normal wear on bearing surfaces in drag link end socket will result in increased overall height of the assembly. If excessive play is noted, drag link ends must be disassembled for replacement of worn parts.

1. Disconnect drag link ends from steering arm and Pitman arm by removing cotter pins and nuts (19) from end studs and driving studs out of arms.

2. Loosen clamp bolt nuts (3) and unscrew drag link end from drag link at steering arm end.

3. Remove dust seal (16), outer dust cover washer (17), and inner dust cover washer (15) from stud end (18).

4. Pry end plug lock (8) out of drag link end socket (6); then remove end plug (7), end stud seat spring (9), end stud seat (12), grease retainer (10), socket centering spring (11), end stud (18), end stud bearing (13), and end stud bearing race (14) from drag link end socket.

CLEANING AND INSPECTION (Fig. 19)

1. Immerse all parts except dust seal in a suitable cleaning solvent. Use a stiff bristle brush, as required, and clean parts thoroughly.

2. Check all parts for wear or corrosion and discard parts that are badly damaged.

3. Check tension of end stud seat spring (9) and centering socket spring (11). Discard springs if tension is not within limits. Refer to "Specifications" at end of this section.

4. Carefully inspect rollers in end stud bearing assembly (13) for roughness or flaking. If rollers will not rotate freely in bearing race (14), bearing assembly should be replaced.

ASSEMBLY AND INSTALLATION (Fig. 19)

Keep all parts clean when performing assembly operations. If dirt or grit is allowed to get into drag link end socket when assembling, premature and excessive parts wear will result.

1. Lubricate all parts with lubricant specified in LUBRICATION (SEC. 13); then place end stud bearing (13) and end stud bearing race (14) on end stud (18).

2. Insert end stud and bearing assembly into drag link end socket (6); then press grease retainer (10) over spring seat (12). Place centering socket spring (11) and spring seat in drag link end; then install end stud seat spring (9) and end plug (7). Secure parts in drag link end socket (6) with end plug lock (8).

3. Install on threaded end of stud, in following order, inner dust cover washer (15), outer dust cover washer (17), and dust seal (16).

4. Install drag link end assembly on drag link, but do not tighten clamp bolt nuts.

5. Place drag link in position on coach and attach to steering arm and Pitman arm with lock nuts. Tighten nuts to torque listed in "Specifications," and advance to nearest cotter pin slot. Install new cotter pins.

6. Adjust length as previously directed under "Length Adjustment" in this section; then lubricate as directed in LUBRICATION (SEC. 13) of this manual.

SPECIFICATIONS

STEERING COLUMN

Steering Wheel Diameter	22″
Steering Bevel Gear Assembly	
Ratio	1.5 to 1
Total Ratio Bevel Gear and Steering Gear	38.4 to 1
Upper Bevel Pinion	
Number of Teeth	18
Lower Bevel Gear	
Number of Teeth	27
Backlash Between Gears	
Without Any Bind in Gears	Max. 0.002″
Backlash Adjustment Method Upper Bevel Pinion	Shims
Shim Thickness	0.003″ and 0.010″
End Play	None
Lower Bevel Gear	Adjuster Screw
End Play	None

BEARINGS

Lower Steering Shaft Upper	
Type	Roller
Outside Diameter	1.6250″-1.6260″
Inside Diameter	1.1245″-1.1250″
Width	1.6250″-1.6260″
Number of Rollers	12
Lower Steering Shaft Lower	
Type	Roller
Inside Diameter	1.002″-1.007″
Outside Diameter	1.542″-1.552″
Width	0.0779″-0.0781″
Number of Rollers	30
Bearing Race	
Inside Diameter	1.002″-1.012″
Outside Diameter	1.532″-1.552″
Thickness	0.123″-0.126″

SPECIFICATIONS (CONT.)

BEARINGS (Cont.)

Directional Switch
- Type .... Ball
- Ball Diameter .... 0.125″
- Number of Balls 26

Bevel Gear
- Type .... Roller
- Inside Diameter .... 0.377″-0.382″
- Outside Diameter .... 0.792″-0.802″
- Width .... 0.0779″-0.0781″
- Number Rollers 12

Bearing Race
- Inside Diameter .... 0.377″-0.387″
- Outside Diameter .... 0.782″-0.802″
- Width .... 0.030″-0.032″

Bevel Gear Housing
- Type .... Needle Bearing
- Inside Diameter .... 0.9995″-1.0000″
- Outside Diameter .... 1.2495″-1.2505″
- Width .... 0.740″-0.750″

Housing Cap
- Type .... Needle Bearing
- Inside Diameter .... 1.4995″-1.5000″
- Outside Diameter .... 1.8745″-1.8755″
- Width .... 0.990″-1.000″

Steering Column Universal Joint
- Type .... Roller
- Number Rollers 20

STEERING GEAR

- Make .... Saginaw
- Type .... Recirculating Ball and Sector Nut
- Gear Ratio .... 25.6 to 1
- Model 572-D-1

Worm Nut
- Type .... Ball
- Ball Diameter .... 0.3749″-0.3751″
- Number of Balls 84

Adjustments

Worm Bearings
- Adjustment Type .... Shims
- Shim Sizes Available .... 0.002″, 0.005″, 0.010″, and 0.030″

NOTE: Use a minimum of (3) 0.002″ and (2) 0.005″ thick shims.

- End Play in Worm .... None
- Pull to Keep the Worm Moving .... 1½ to 2 lbs. at 9″ radius

Pitman Shaft Lash
- Adjustment Type .... Adjuster Screw
- Pull Over Center (Includes Worm Bearing Load) 2¾ to 3¼ lbs. at 9″ radius

Back-Up Adjuster...Screw in until stop bottoms; then back off ¼ turn and tighten lock nut to 30-50 foot-pounds torque.

BEARINGS
- Worm Thrust .... Tapered Roller
- Pitman Shaft—Type .... Needle

Housing
- Inside Diameter .... 1.8730″-1.8735″
- Outside Diameter .... 2.4369″-2.4375″
- Width .... 1.245″-1.250″

Side Cover
- Inside Diameter .... 1.7495″-1.7500″
- Outside Diameter .... 2.1245″-2.1255″
- Width .... 0.990″-1.000″

STEERING DRAG LINK

- Type .... Adjustable Length
- Length—Centerline of Stud Centers .... Approx. 33.22″—will vary

Springs

Stud Seat Spring
- Free Length .... 0.750″
- Compressed Length Under 350-400 lbs. .... 0.500″

Socket Centering Spring
- Free Length .... 1.250″
- Compressed Length Under 30 lbs. .... 0.875″

STEERING PROPELLER SHAFTS

- Universal Joint (Slip Joint End) Front and Rear Shafts .... 1281 Series
- Universal Joint (Fixed Joint End) Front and Rear Shafts .... 1288 Series
- Journal Diameter .... 0.5965″-0.5970″
- Bearing Rollers—Quantity 23

Length—Front Shaft
- End of Yoke at Slip Joint to Centerline of Journal at Fixed Joint End .... 19⁷⁄₁₆″

Length—Rear Shaft
- Center Line of Journal at Slip Joint End to Centerline of Journal at Fixed Joint End .... 22⁵⁄₁₆″

PROPELLER SHAFT SUPPORT

BEARINGS
- Inside Diameter .... 1.1811″ + 0.0000″ − 0.0004″
- Outside Diameter .... 2.8346″ + 0.0000″ − 0.0005″
- Width .... 1.1875″ + 0.0000″ − 0.005″
- Number of Balls .... 12 per Row
- Size of Balls .... ⁷⁄₁₆″

STUB SHAFT
- Length .... 4″
- Diameter .... 1.177″-1.179″
- Number of Splines 10

TORQUE SPECIFICATIONS

Location	Ft.-Lbs.
Steering Wheel Retaining Nut	45-50
Universal Upper Housing to Jacket Bolt Nut	15-20
Universal Lower Housing to Upper Housing Bolt	20-25
Steering Column Shaft to Universal Joint Lock Nut	20-25
Steering Column Clamp Plate Support Nut	15-20
Steering Column Clamp Plate to Support Bolt	30-35
Bevel Gear Bracket to Side Member Nut	25-30
Bevel Gear Housing to Bracket Nut	35-45
Steering Column U-Bolt Nut	5-7
Propeller Shaft Yoke to Bevel Gear Shaft Nut	15-20
Propeller Shaft U-Bolt Nut	15-20
Bevel Gear Cover to Housing Bolt	25-30
Pinion Gear to Shaft Retaining Nut	40-50
Bevel Gear Cap to Housing Bolt	20-25
Steering Gear Support Clip Nut	90-110
Steering Gear to Support Stud Nut	45-55
Steering Gear Housing to Axle Bolt	170-180
Drag Link to Steering-Arm Nut — And advance to nearest cotter pin slot.	125-150
Drag Link to Pitman Arm Nut — And advance to nearest cotter pin slot.	125-150
End Socket to Tie Rod Clamp Nut	65-80
End Socket to Drag Link Clamp Nut	45-55
Pitman Arm to Steering Gear Shaft Nut	250-300
Steering Gear Side Cover Bolt	25-35
Steering Gear Adjuster Screw Lock Nut	25-35
Steering Gear Back-Up Adjuster Lock Nut	30-50
Steering Gear Cap Cover to Housing Bolt	35-45
Steering Gear End Yoke Nut	50-75

Power Steering

The power steering system, available as special equipment on coaches covered in this manual, provides automatic hydraulic assistance to the turning effort applied to the mechanical steering system. The power steering is adaptable to the standard mechanical steering described previously with a minimum amount of alterations.

The power steering system consists primarily of three units, used in conjunction with the conventional steering gear:

1. Control Valve.
2. Booster Cylinder.
3. Hydraulic Pump.

NOTE: The steering gear assembly, used with the power units on coaches equipped with power steering, is the same as the steering gear assembly described earlier in this section under "MECHANICAL STEERING" system.

OPERATION

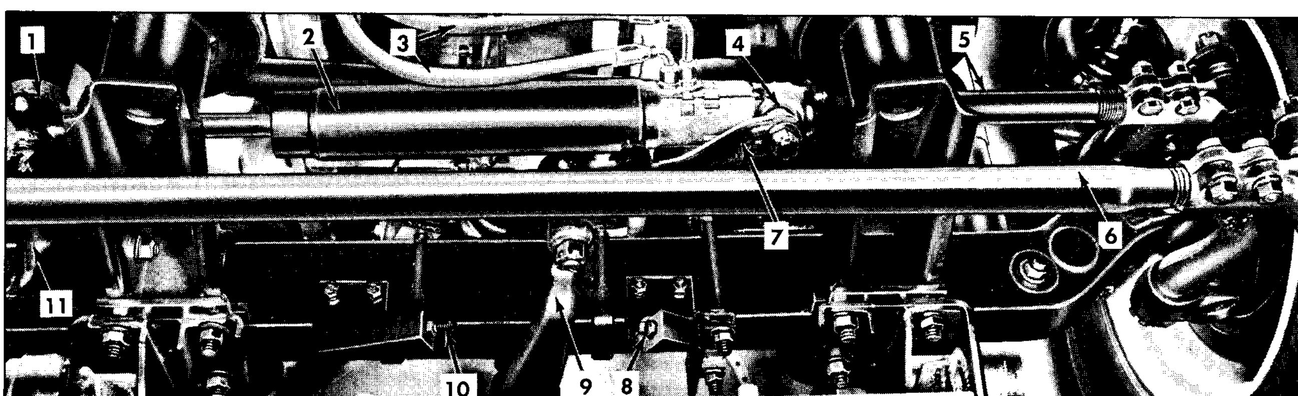
Power steering is accomplished through use of hydraulic pressure. Hydraulic fluid is supplied by a vane-type oil pump mounted at left rear of the engine. The pump is driven, through a coupling, by engine blower drive shaft. Fluid displaced by the pump is circulated through flexible fluid lines to a self-contained actuating booster cylinder installed on the front axle (fig. 1). Movement of steering wheel is transmitted through conventional Pitman arm and drag link to a control valve located in booster cylinder. This control valve directs hydraulic fluid, under pressure displaced by hydraulic pump, to either side of a piston in the booster cylinder, producing movement of piston and attached drag link of the coach steering linkage. Force applied by booster cylinder to drag link is automatically the amount of thrust necessary for all steering requirements.

MAINTENANCE

The power steering hydraulic system requires little maintenance. However, the system should be kept clean to insure maximum operating performance and trouble-free service. Periodic inspection to check for leaks should also be made.

At regular intervals the hydraulic fluid level in pump reservoir should be checked and fluid added when required. Refer to LUBRICATION (SEC. 13) of this manual for type fluid to be used, method, and intervals for filling.

The fluid reservoir and filter assembly is



1 Piston Rod Socket Assembly	7 Drag Link Assembly
2 Booster Cylinder Assembly	8 Pitman Arm Right-Hand Stop
3 Pressure and Return Line Hoses	9 Pitman Arm
4 Booster Cylinder Ball Stud	10 Pitman Arm Left-Hand Stop
5 Extension and End Socket Assembly	11 Piston Rod Socket End Support
6 Steering Tie Rod	

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Figure 1—Power Steering Booster Cylinder Installed

mounted in the upper right-hand corner of the engine compartment (fig. 2). When the slightest evidence of dirt, sludge, or water is discovered in the system, drain and refill with clean recommended hydraulic fluid. To drain system, disconnect fluid lines at booster cylinder.

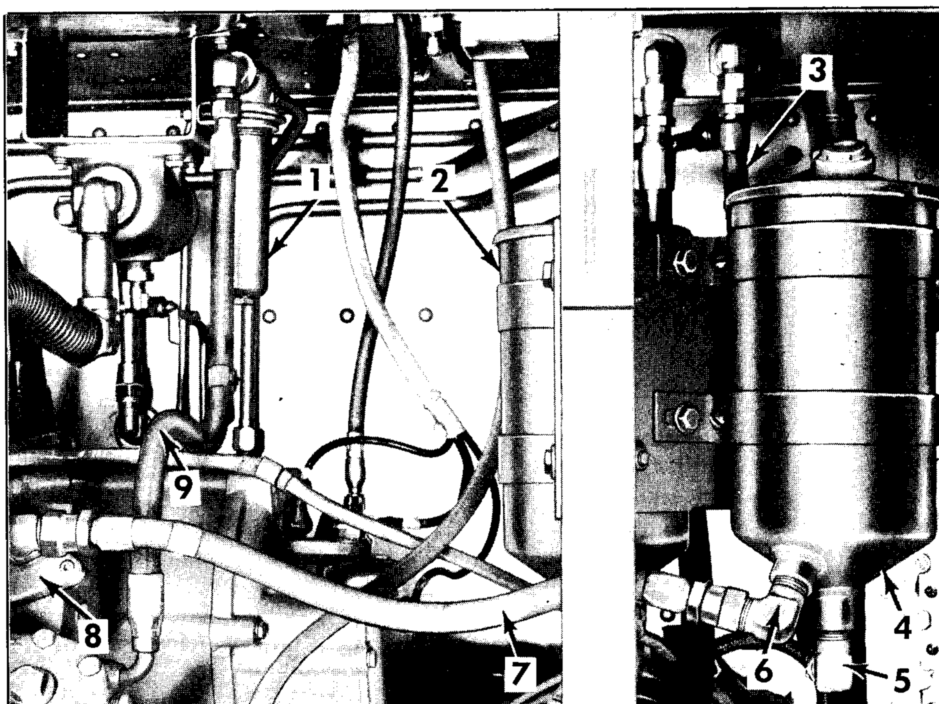
Power steering fluid filters should be serviced at regular lubrication intervals. Refer to instructions under heading of "Power Steering Fluid Reservoir and Filters" in this section.

Air in the fluid system will cause spongy action and noisy operation. When any hose has been disconnected or when fluid has been lost for any reason, the system must be bled after adding fluid. Bleed system as directed later in this section under "Bleeding Power Steering Hydraulic System." Should the power steering system become inoperative because of loss of hydraulic fluid, pump pressure line should be re-routed from pump outlet directly back to pump reservoir.

IMPORTANT: Do not operate pump without fluid in the pump reservoir.

If steering linkage between steering gear and front wheels is out of adjustment, bent, twisted, or worn, steering action of coach will be seriously affected. At any time steering linkage parts are repaired, replaced, or adjusted, steering geometry and front wheel alignment must be checked. Refer to FRONT AXLE (SEC. 1) of this manual for front end alignment information.

At regular lubrication intervals, the steering linkage should be checked completely for worn or loose ball stud end sockets.



1 Fluid Line Filter
2 Air Conditioning Reservoir
3 Return Line From Booster
4 Power Steering Reservoir
5 Power Steering Reservoir Inlet
6 Power Steering Reservoir Outlet
7 Return Line to Hydraulic Pump
8 Power Steering Hydraulic Pump
9 Pressure Line to Booster

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Figure 2—Power Steering Pump, Filter, and Reservoir Installed

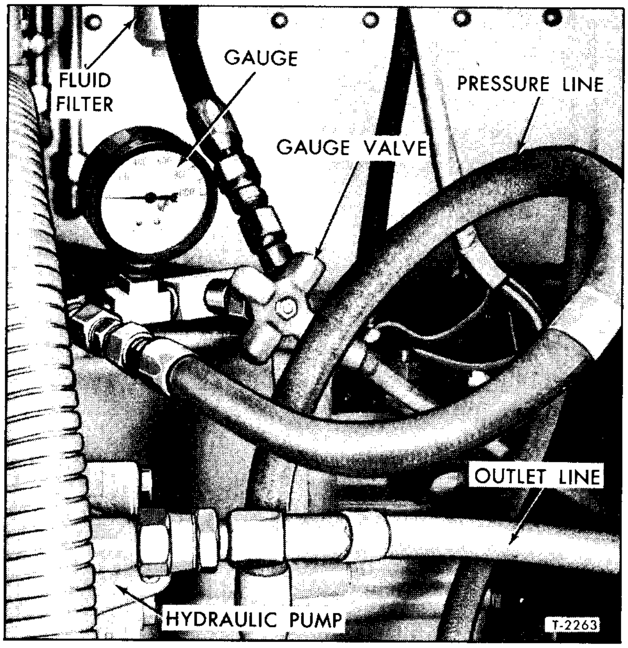


Figure 3—Checking Pump Hydraulic Pressure (Typical)

If coach steering tends to wander in one direction, after making certain that front end is properly aligned, cause may be that the control valve in booster cylinder may not be centering properly.

BLEEDING POWER STEERING HYDRAULIC SYSTEM

When power steering hydraulic pump, booster cylinder assembly, or fluid reservoir and filter assembly has been removed for overhaul or replacement, or any hydraulic system lines disconnected, the hydraulic system must be bled before vehicle is again operated. Bleed power steering hydraulic system as follows:

NOTE: When hydraulic fluid is added to power steering system, fluid should be poured through a 200 mesh wire screen secured inside funnel. Use only the hydraulic fluid recommended in LUBRICATION (SEC. 13) of this manual in the power steering hydraulic system.

1. Fill power steering pump reservoir tank to "FULL" mark on dipstick. Let hydraulic fluid remain undisturbed for about two or three minutes.
2. Raise front end of coach until front wheels are well off floor.
3. Eliminate air pockets in booster cylinder and hydraulic system by turning front wheels to right and left Pitman arm stops. Continue this procedure, while maintaining fluid level in pump reservoir tank to "FULL" mark on dipstick, until fluid in pump tank stops bubbling.
4. Start engine and run at idle for two or three minutes. Turn front wheels to right and left as before. DO NOT HIT WHEEL STOPS. Maintain fluid level in pump reservoir tank to "FULL" mark on dipstick. Check system lines and connections for leaks. Continue these procedures until fluid in pump reservoir tank is clear and free of bubbles.
5. Increase engine speed to approximately half throttle and run engine at this speed until all signs of air bubbles cease to exist in pump reservoir tank. Turn wheels to right and left as before. DO NOT HIT PITMAN ARM STOPS.
6. Lower coach to floor and turn wheels to right and left while rechecking for fluid leaks.
7. Recheck fluid level in pump reservoir tank and fill to "FULL" mark on dipstick.

HYDRAULIC PRESSURE TEST

1. Disconnect pressure hose from fitting at the hydraulic pump.

NOTE: Some hydraulic fluid will leak out when line is disconnected. Provision should be made to catch this drainage.

2. Connect 0 to 1000 psi pressure checking gauge (J-5631-1) (fig. 3) between the pump pressure line and power steering fluid filter. Leave valve in pressure gauge line open.
3. Bleed steering hydraulic system to remove all air from pressure line as directed previously under "Bleeding Hydraulic System."
4. Start engine and run at idle speed. Turn wheels through normal operating range several times until the hydraulic fluid temperature reaches 170°F. When fluid temperature reaches 170°F., close valve in pressure gauge line and observe reading on pressure gauge. Pressure reading should be 950 to 1050 psi.

IMPORTANT: Do not leave valve closed for more than 15 seconds.

5. Open valve in pressure gauge line. Turn wheels to extreme right and left against "stops" (with wheels on ground). At extreme right or left position the maximum pressure reading should be within the amount specified in procedure 4 above.
6. If pump pressure is less than amount specified, make necessary repairs described under "Hydraulic Pump Overhaul" later in this section.
7. If pump pressure is satisfactory, shut off the engine and remove pressure checking gauge.
8. Reconnect pressure hose to steering fluid filter; then bleed hydraulic system as described previously under "Bleeding Power Steering Hydraulic System."

POWER STEERING BOOSTER CYLINDER

GENERAL

The cutaway view in figure 4 illustrates the assembly and construction of the integral steering unit. Fluid flow from the pump is directed by the valve spool through internal ports into the cylinder to operate the piston.

The rod end of the steering cylinder piston is anchored to the vehicle. The cylinder and valve body are connected to the wheels through the extension and end socket assembly and the valve spool is linked to the steering gear by the drag link assembly. Road shock forces on the wheels tend to move the cylinder, but this action also moves the valve body in relation to the spool, which is being held by the drag link. Movement of the valve body relative to the valve spool directs oil to the cylinder to compensate for the road shock loads and to maintain vehicle directional control at the steering wheel.

When the valve spool is moved in either direction by movement of the steering wheel and drag link, oil is directed to the cylinder. This causes the cylinder and valve body to move in the desired direction relative to the piston and rod which is anchored to the vehicle. Movement of the cylinder and valve body, which, through the extension and end socket assembly are connected to the wheels, steers the vehicle.

OPERATION

(Refer to Figure 5)

Neutral Position - Neutral position is obtained when free hydraulic flow from the valve inlet to outlet is provided by the position of the control spool in relation to internal passages.

Extend or Retract - Movement of the steering wheel in either direction is transmitted through

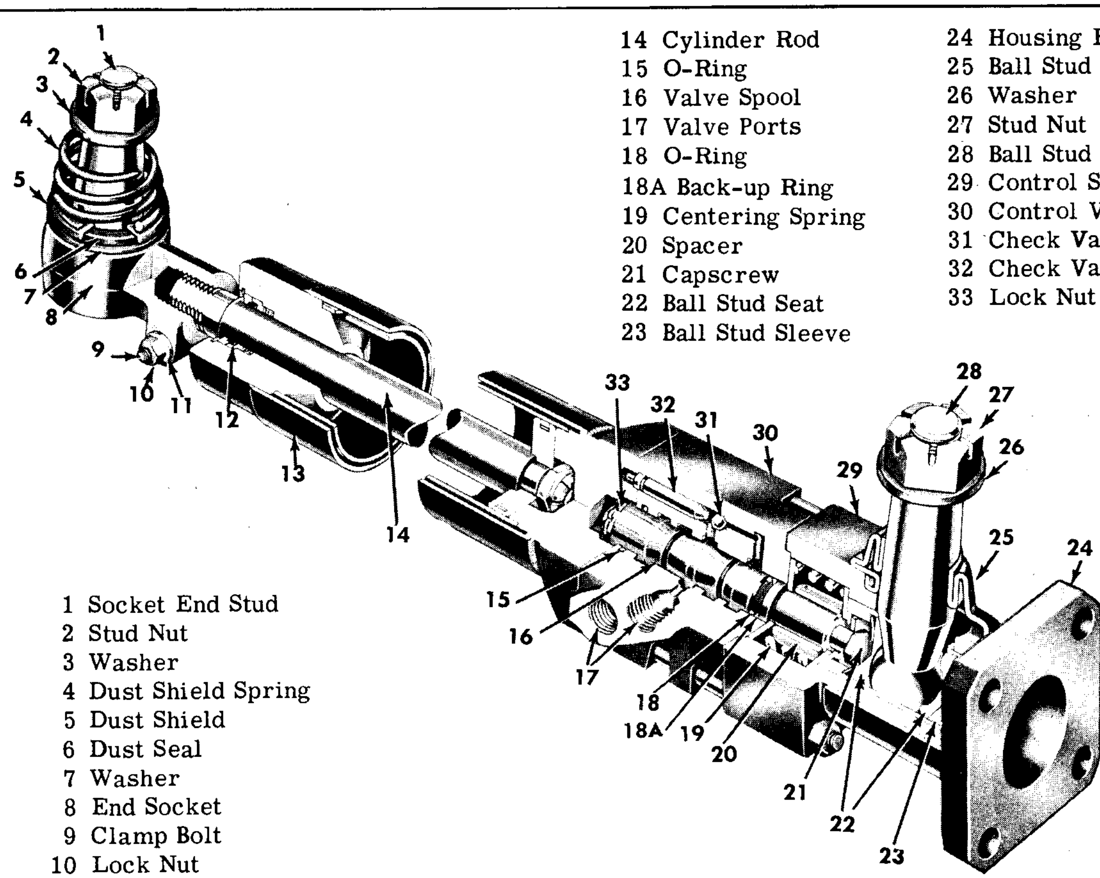


Figure 4—Power Steering Booster Cylinder Assembly

POWER STEERING

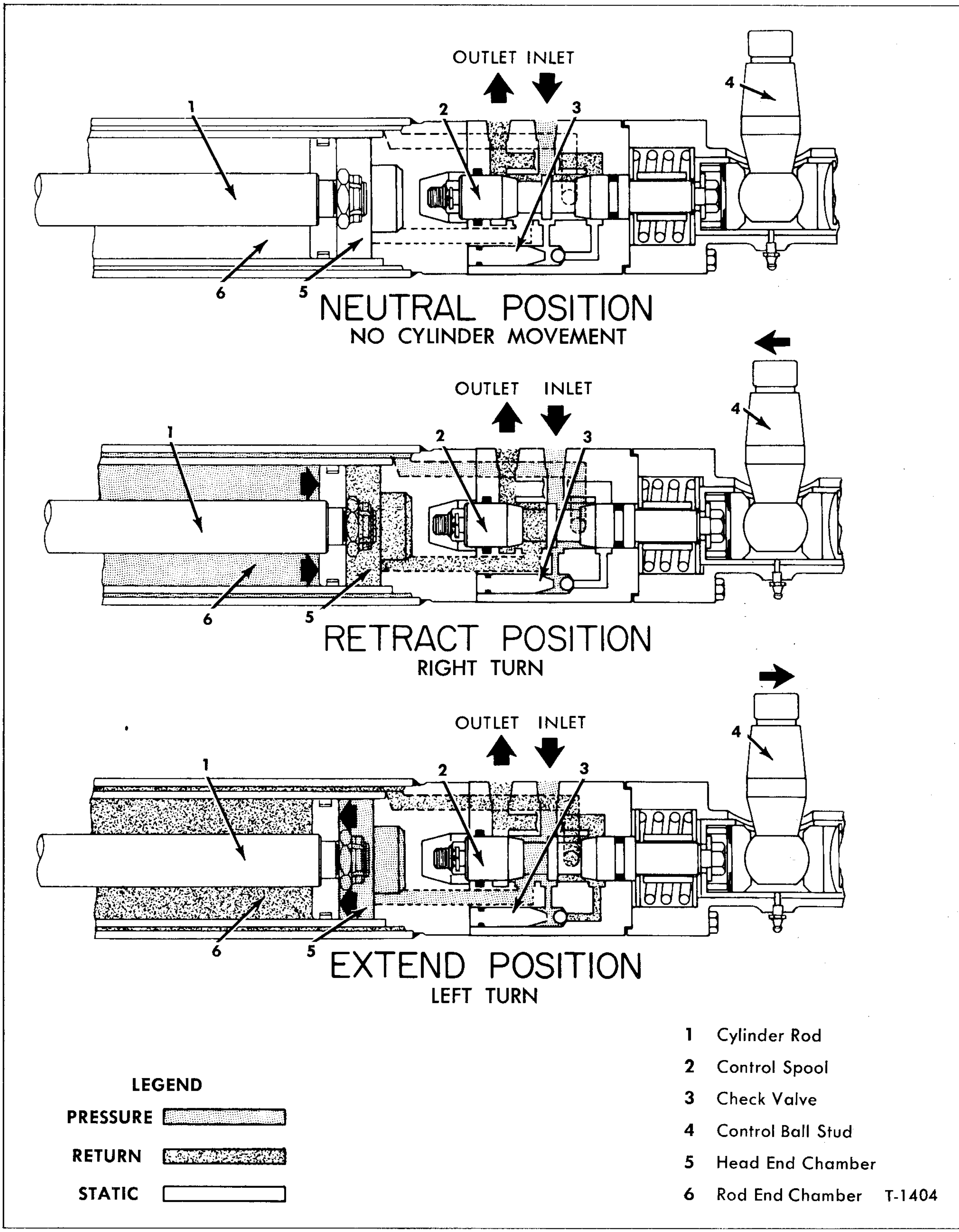


Figure 5—Operational Diagrams of Steering Booster Cylinder

mechanical linkage to the control valve ball stud. Movement of the ball stud causes movement of the control spool. Pump oil flow is directed by spool position to either the head end or rod end of the cylinder, causing the cylinder to extend or retract. Movement of the cylinder will continue as long as the control spool is offset by continued turning of the steering wheel. When the steering wheel stops turning, the control spool stops and the cylinder and valve body move to center (Neutral) position and stop. This is true in any position of the steering wheel if steering Pitman arm stops are provided to prevent the cylinder from bottoming with the wheels against the wheel stops.

Pressure - In the event of power source failure, the ball check in the steering control valve body will permit free flow of oil throughout the steering unit. This permits the steering system to be operated manually.

Malfunction - For diagnosis and remedy of trouble relative to power steering booster assembly, see "Booster Cylinder Trouble Shooting Chart" in this section.

BOOSTER CYLINDER REPLACEMENT

Power steering booster cylinder assembly, installed as shown in figure 1, can be readily removed from coach at any time service is required that necessitates disassembly or partial disassembly of the unit. Remove booster cylinder assembly from coach as described in the following text. When reinstalling booster cylinder assembly, be sure to accomplish adjustment procedures outlined.

REMOVAL

Key numbers in text refer to figure 1.

1. Attach identification tags to flexible pressure and return hoses (3), then remove hoses and drain fluid from hoses and cylinder.
2. Remove cotter pin and stud nut attaching adjustable steering drag link (7) to booster cylinder ball stud (4). Discard cotter pin.
3. Remove cotter pin and stud nut attaching piston rod end socket tapered stud (1) to piston rod socket end support (11). Discard cotter pin.
4. Remove four cotter pins, nuts, and bolts attaching flange of booster cylinder ball stud body (4) to flange of adjustable extension (5).
5. Remove booster cylinder assembly (2) from drag link end (7) and Pitman rod socket end support (11). It may be necessary to use a suitable puller to aid in removal.
6. Remove dust cover spring and dust cover from booster cylinder ball stud (4).
7. Remove dust cover spring, shield, dust cover, and washer from piston rod end socket tapered stud (1).
8. If necessary, remove set screw and clamp bolt; then turn piston rod end socket (1) off piston rod.

INSTALLATION

Refer to figures 1 and 6; key numbers refer to figure 1.

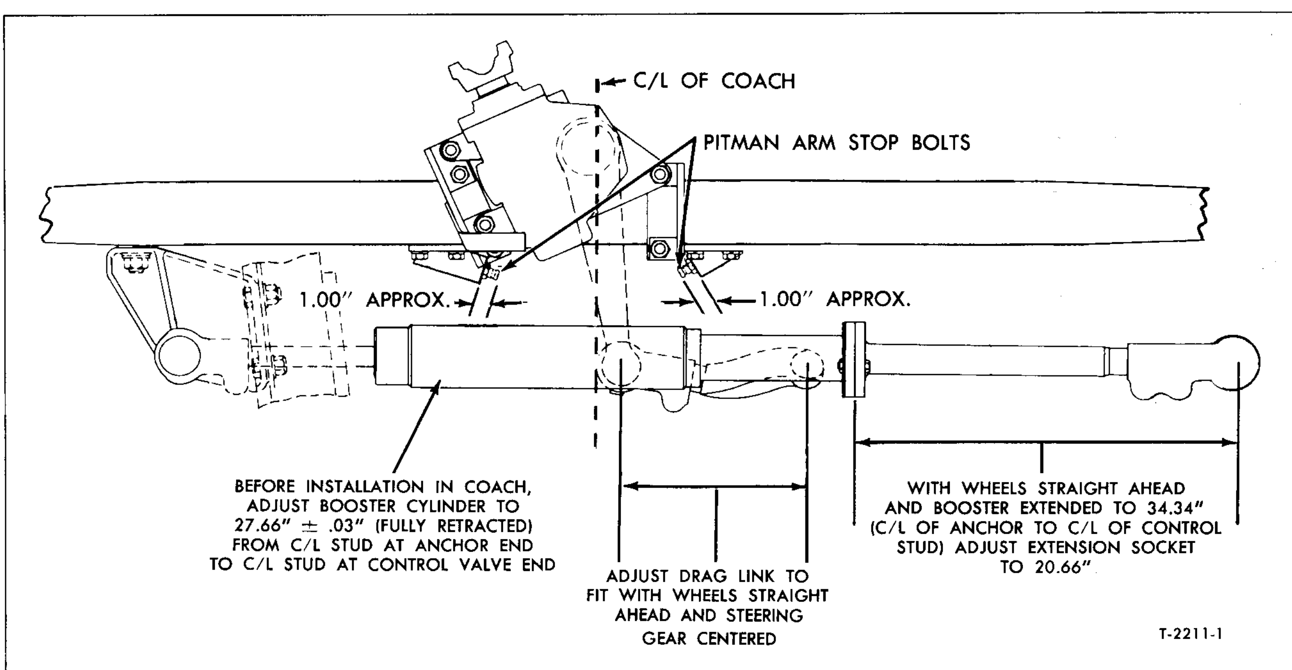


Figure 6—Power Steering Booster Cylinder Installation

POWER STEERING

1. Before installing booster cylinder (2) assembly in coach, compress booster cylinder into fully retracted position; then thread piston rod end socket assembly (1) on booster cylinder piston rod to the dimension shown in figure 6, measured from centerline of socket end tapered stud (1) to centerline of booster cylinder ball stud (4).

2. Position dust cover and dust cover spring on booster cylinder ball stud (4).

3. Position washer, dust cover, shield, and dust cover spring on piston rod end socket tapered stud (1).

4. Check length of cylinder extension and end socket assembly (5), measuring from center of end socket ball stud to flange of extension (fig. 6). Distance should measure 20.66". Adjust as necessary to obtain this dimension.

5. Set wheels in straight ahead position and extend booster cylinder to 36.34" (measure from C/L of piston rod end socket stud (1) to C/L of cylinder ball stud (4).

6. At this stage of installation the booster cylinder (2) should be suspended horizontally under coach and fluid lines (3) connected to unit.

7. Position booster cylinder ball stud body flange (4) to flange of end socket extension (5), at the same time inserting booster cylinder ball stud (4) in hole at end of drag link (7) and piston rod end socket tapered stud (1) into hole in piston rod socket end support (11).

NOTE: Cylinder ball stud to drag link must be positioned at bottom of cylinder and tilted away from axle 35 degrees. When booster cylinder and end socket extension are pre-set to above dimensions, the studs (1 and 4) should slip easily into the holes in drag link (7) and support (11). Turn adjustable drag link for further adjustment if necessary.

CAUTION: If excessive adjustment is necessary, after pre-setting to above dimensions, this is an indication that something else is wrong. Check for bent steering arm, misaligned front end or worn components of steering linkage.

8. Dip threads of extension bolts in grease containing zinc oxide (#3); then attach booster cylinder ball stud body flange (4) to flange of end socket extension (5) with four bolts and lock nuts. Tighten bolts to torque listed in "Specifications"; then advance lock nuts to nearest cotter pin holes and install new cotter pins.

9. With booster cylinder ball stud inserted through hole at end of drag link, install stud nut on ball stud. Tighten stud nut to torque listed in "Specifications"; then advance nut to nearest cotter pin hole and install new cotter pin.

10. With piston rod end socket tapered stud (1) inserted through hole in support (11), install stud nut on tapered stud. Tighten nut to torque listed in "Specifications"; then advance nut to nearest cotter pin hole and install new cotter pin to retain nut.

IMPORTANT: It is important that the following adjustments be checked.

11. Locate center of steering gear by turning steering wheel from extreme left to extreme right with Pitman arm stops removed, counting exact number of turns, then back exactly half way. Mark steering gear worm shaft yoke for center position.

12. If steering gear is incorrectly positioned, disconnect drag link (7) from Pitman arm. Loosen clamp bolt securing end socket to drag link. With steering gear positioned as described in Step 11, and front wheels and steering wheel in straight-ahead position, turn end socket on drag link as required to align center of end stud with center of hole in Pitman arm. Attach end socket to Pitman arm. Tighten stud nut to torque listed in "Specifications." Install new cotter pin.

IMPORTANT: Booster cylinder end of drag link must be tilted to same plane as flange of booster cylinder ball stud body before clamp bolt at Pitman arm end socket is tightened; stud must clear bellows support in extended position. Rotate link if necessary, then tighten bolt to torque listed in "Specifications."

13. Refill power steering hydraulic system and bleed system as directed previously under "Bleeding Power Steering Hydraulic System."

14. Pitman arm stops are primary stops. Wheel stops should be set to have a clearance of 1/8 to 3/16 inch. This can save the hydraulic pump from damage by overheating as when held against wheel stops.

BOOSTER CYLINDER OVERHAUL

DISASSEMBLY

Key numbers in text refer to figure 7.

NOTE: If ball stud housing (41), valve body (25) and cylinder tube (17) have not been scribed with alignment marks, use prick punch and mark these parts so they can be reassembled in same relative position.

CAUTION: Before removing unit or parts of unit to be serviced be certain the unit is not subject to hydraulic pressure.

Do not disassemble a unit further than is necessary to correct a malfunction. During disassembly, special attention should be given to identification of parts for proper reassembly. Place all disassembled parts on a clean, lint-free surface for inspection. Carefully remove any burrs by light stoning. Clean all parts except O-rings and seals in a clean mineral oil solvent. After drying thoroughly, lay the parts on a clean, lint-free surface. All internal oil passages of the unit must be thoroughly cleaned.

CAUTION: Never use an air hose on or near the exposed parts because of the presence of water and dirt in the air system.

All O-rings and seals should be replaced for reassembly. Soak them in hydraulic fluid prior to being used.

Control Valve Disassembly

1. Loosen and remove four stud nuts (43) that secure the control ball stud housing (41) and valve assembly to the cylinder. Remove the control ball stud housing and valve assembly from the cylinder. Remove three O-rings (24) from recesses in the valve body (25). Care must be taken not to score or otherwise damage the cylinder or valve body mating surfaces.

2. Hold control ball stud housing and valve body assembly in a vise, by lightly clamping valve body (25). Use care not to distort spool bore in valve body. Remove snap ring (46) and washer (45). Remove the lock pin (44) which secures the control ball stud sleeve plug (40) and remove plug. Remove control ball stud (38), two ball stud seats (37), spring washer (36).

3. Remove cotter pin (20) and self-locking nut (21) from bolt (35). Remove control spool O-ring (22) from valve body. Remove cap screw (35), washer (34) and control ball stud sleeve (33). Then lift the two centering spring retaining washers (32 and 29), centering spring (31), and spacer (30) from the valve body (25). Remove control spool (26) from the control ball stud end of valve body (25). Remove O-rings (27 and 28) and back-up ring (28A) from valve body and from spool.

NOTE: The check valve retaining plug with integral valve body-cylinder locating pin should be removed for inspection of valve (19) and ball (23).

Cylinder Disassembly

The cylinder assembly is a sealed unit. Overhaul procedures are restricted to replacing the sealing parts on the rod end.

1. Remove rod end ball stud (3) by removing nut (1), bolt (10), and lock washer (2) from the ball stud housing and unscrewing the ball stud (3).

2. Remove retainer snap ring (11) with snap ring pliers. Rotate the rod and withdraw it far enough from the cylinder to expose scraper (12), wiper ring (13), retainer (14) and washer (15). The shaft seal assembly (16) may be removed with a hooked scriber.

INSPECTION

1. Discard all seals, wipers, scrapers, and bolt and nut (21 and 35, fig. 7) and replace with new parts upon reassembly. Wash all parts in a good grade of mineral spirits.

2. Inspect all fluid passages in valve body and

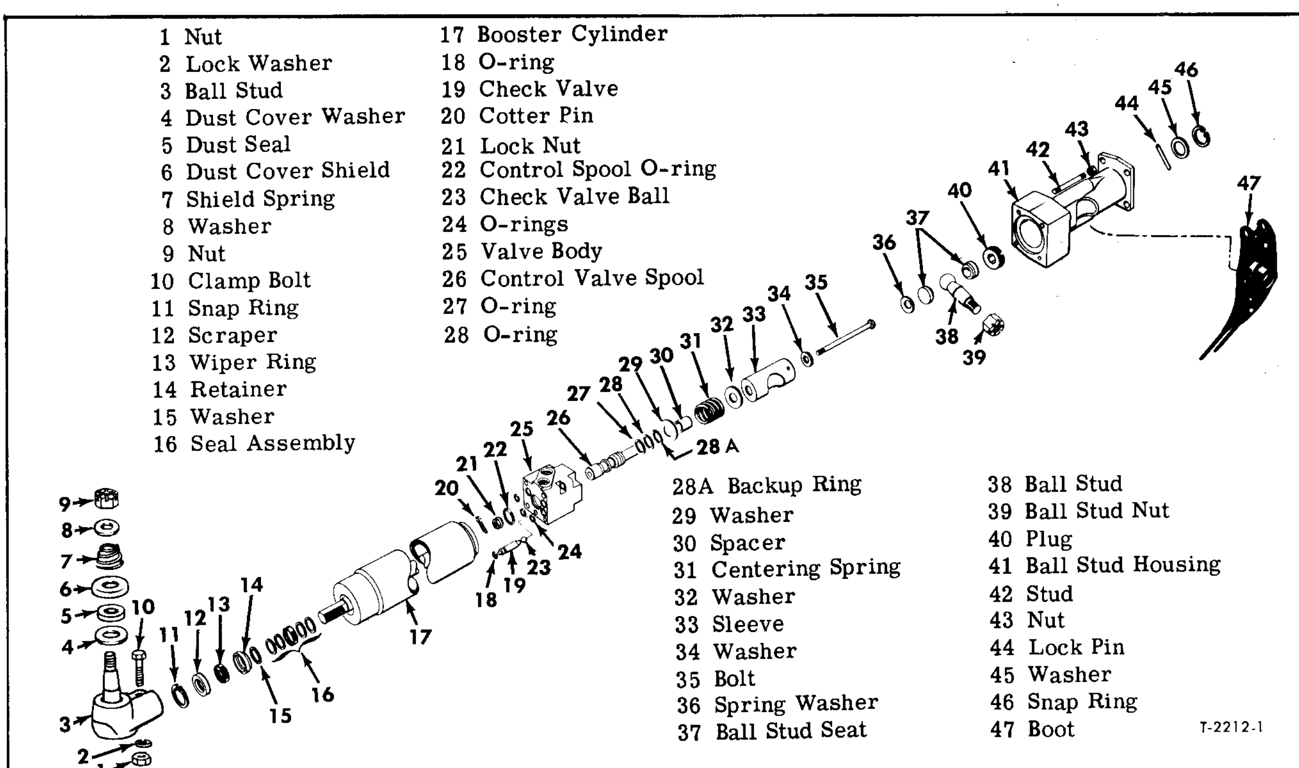


Figure 7—Power Steering Booster Cylinder Components

cylinder to be certain they are clean and free from obstructions.

3. Check each disassembled part for excessive wear, cracks or pitting that would render them unfit for continued use. Replace all defective parts.

4. Inspect valve spool for deep scoring and excessive wear. Check valve spool bore for similar scoring or pitting. Replace these parts if badly damaged or worn. Do not rework or attempt to "touch-up" the valve spool. This practice will only result in improper steering unit operation and performance.

5. Inspect cylinder shaft for damage and straightness to insure proper seating.

ASSEMBLY

NOTE: Immerse all parts in clean hydraulic fluid to facilitate reassembly.

Seals - Be sure that all old seals, wipers and scrapers are discarded and replaced with new parts for reassembly. Remember that a seal can only do its job when properly seated to prevent fluid leakage and entrance of air into the system. Coat all seals with liberal amounts of grease or petroleum jelly prior to assembly.

Control Valve Assembly

1. Install new O-rings (22, 27 and 28 - coated with grease or petroleum jelly) in cylinder end of valve body and on control ball stud end of valve spool. Install spool in bore from the control ball stud end to avoid O-ring interference during assembly.

2. Install washer (29), spacer (30), centering spring (31), washer (32), control ball stud sleeve (33), cap screw washer (34) and new bolt (35). Coat screw threads with a small amount of grade D "Locktite" or equivalent. Install a new self locking nut (21) and tighten firmly. Be sure that the centering spring remains aligned between the two retaining washers. Back nut (21) off 1/3 turn or 120°. Drill one 0.078" hole through center of nut and bolt next to bottom of taper on nut. Install new cotter pin. CAUTION: Do not drill more than one hole

BOOSTER CYLINDER TROUBLESHOOTING CHART

TROUBLE	PROBABLE CAUSE	REMEDY
LOSS OF SYSTEM PRESSURE	SLIPPAGE OF PUMP DRIVE OTHER PUMP MALFUNCTION.	Refer to "Hydraulic Pump Trouble Shooting Chart."
CYLINDER PISTON ROD BINDING OR STICKING	CRAMPING OF LINKAGE.	With hydraulic flow shut off from the unit and the rod end uncoupled the rod should slide freely in or out by hand with a maximum force of 30 pounds. If binding is apparent, replace the unit and readjust Pitman arm stops to prevent recurrence of damage.
CHATTER CONDITIONS	LOOSE MOUNTINGS OR LINKAGE.	Make certain all ball stud mounting and other linkage is tight. Check Pitman arm stops to be certain the arm strikes the stops slightly before the steering knuckles contact the stops on the axle. Insufficient pump flow at idle speeds can be corrected by increasing engine idle rpm.
UNSATISFACTORY STEERING IN EITHER DIRECTION	AIR IN SYSTEM, EXCESSIVE WEAR IN STEERING CYLINDER. INCORRECT SYSTEM PRESSURE, WORN PUMP.	Check for air in system. Excessive noise or foamy condition of oil indicates aeration. Check to be sure air is not entering system through poor threads, hoses, pump seals, O-rings, gaskets and loose connections. Excessively worn cylinders result in leakage past the piston. Correct by replacing cylinder. Repair or replace pump.

through bolt.

3. Start control ball stud sleeve plug (40) into the ball stud sleeve (33). Pack cavity in ball stud housing (41) in which centering spring (31) is contained at least half full of Special Multi-Purpose Grease.

4. Install three new O-rings (24) in recesses in the valve body (25). Mate surfaces of valve and cylinder. Install ball (23) and check valve (19). The locating pin on the check valve retaining plug must mate with a recessed hole on the cylinder mating face to insure proper port alignment between cylinder and valve.

5. Locate control ball stud housing (41) in desired position relative to control ball stud. Install four stud nuts (43) while holding valve end control assembly in place to prevent misalignment of O-rings. Tightening of the four stud nuts (43) should be done evenly and 180 degrees apart to prevent an out-of-square condition between the ball stud housing and valve body. The nuts should initially be tightened only snugly, and then tightened evenly to torque listed in "Specifications" after the control ball stud has been assembled. The ball stud then can be actuated to check if the spool is free. If the spool is not free, the nuts should be loosened and retightened.

6. The spring washer (36) must be installed with its convex (raised inside diameter) face toward ball stud (38) to provide spring tension on ball stud. Next install ball stud seats (37) and control ball stud (38). Position the stud (38) and sleeve (33) so that the stud is centered in the sleeve opening.

7. Tighten control ball stud sleeve plug (40) snugly against seat (37). Back plug off until slot in plug lines with one of the lock pin anchor holes in sleeve which are spaced at 60° intervals in control ball stud sleeve. Install lock pin (44). Install washer (45) and snap ring (46).

8. Grease control ball stud housing, under low pressure, through grease fitting using recommended chassis lubricant.

Cylinder Reassembly

1. Coat the rod seal assembly parts (16) with petroleum jelly. Install two back-up rings over the rod and in the cylihder cap bore. Be sure that the split ends are staggered. Install the seal ring and two outer back-up rings, again with split ends staggered. Install the washer (15), retainer (14), wiper (13) and scraper (12). Install the snap ring (11).

2. Screw the rod end ball stud sub-assembly (3) on to the end of the rod. Install bolt (10) washer (2) and nut (1). Tighten to torque listed in "Specifications."

BOOSTER CYLINDER EXTENSION AND END SOCKET

The booster cylinder extension assembly is two-piece type, composed of an extension and an end socket assembly. Extension is flanged at end which attaches to booster cylinder and threaded at opposite end for attachment of end socket assembly.

End socket stud is held against a tapered bearing by a seat and spring. An end plug and lock wire hold these parts in their correct relative position in end socket (fig. 8).

MAINTENANCE

Tapered stud nut must be kept tight, as any looseness of stud at steering arm will cause hole in arm to become enlarged and result in premature replacement of parts. Tightening stud nut after wear has occurred will result in damage to dust covers and springs, particularly when turning to extreme right and left.

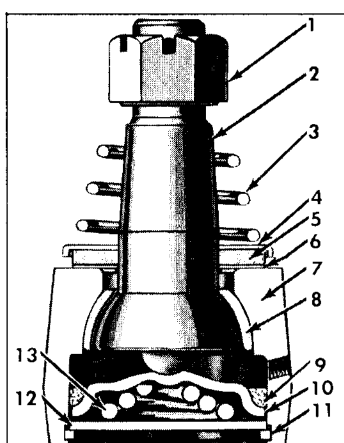
Normal wear on bearing surfaces in end socket will cause increase in overall height of assembly. If excessive play is noted, it is evident that worn parts or complete end socket assembly must be replaced.

At intervals indicated, apply recommended lubricant.

BOOSTER CYLINDER EXTENSION AND END SOCKET REPLACEMENT

REMOVAL

1. Remove cotter pin and nut attaching tapered end socket stud to right-hand steering arm. Strike steering arm a sharp blow with hammer as downward pressure is applied at end socket to remove stud from arm.



1 Stud Nut
2 Tapered Stud
3 Shield Spring
4 Dust Cover Shield
5 Dust Seal
6 Dust Cover Washer
7 Socket Body
8 Bearing
9 Grease Retainer
10 Ball Stud Seat
11 Plug Lock Wire
12 End Plug
13 Seat Spring

Figure 8—Booster Cylinder Extension End Socket

2. Remove four cotter pins, nuts, and bolts attaching extension to booster cylinder assembly. Discard cotter pins.

INSTALLATION

1. With the two clamp bolts loose, turn end socket onto extension until dimension from centerline of tapered stud to face of extension is 20.66". DO NOT TIGHTEN CLAMP BOLTS UNTIL INSTALLATION IS COMPLETE.

2. Set wheels in straight ahead position and extend booster cylinder to 34.34" (measure from C/L of piston rod end socket stud to C/L of cylinder ball stud).

3. Attach extension flange to booster cylinder flange using four bolts and nuts. Tighten bolts to torque listed in "Specifications," then advance lock nuts to nearest cotter pin holes and install new pins.

4. Position dust cover washer, dust seal, dust cover seal, and spring over end socket tapered stud. Insert tapered stud in steering arm. When booster cylinder and end socket extension are preset to above dimensions, the stud should slip easily into hole in steering arm. Turn end socket on extension for further adjustment if necessary.

NOTE: If excessive adjustment is necessary, after pre-setting to above dimensions, this is an indication that something else is wrong. Check for bent steering arm, misaligned front end or worn components of steering linkage.

5. Attach tapered stud to steering arm with nut and new cotter pin. Tighten end socket clamp bolts to torque listed in "Specifications."

BOOSTER CYLINDER EXTENSION AND END SOCKET OVERHAUL

DISASSEMBLY

Key numbers in text refer to figure 8.

1. Remove extension and end socket assembly as previously instructed. Loosen two clamp bolts and nuts; thread socket assembly off extension.

NOTE: If end socket body is not being repaired or replaced, there is no need for removal from extension.

2. Remove shield spring (3), dust cover shield (4), dust seal (5), and dust cover washer (6) from tapered stud (2).

3. Remove end plug lock wire (11), end plug (12), seat spring (13), stud seat (10), and grease retainer (9). When these parts are removed, tapered stud (2), and bearing (8) can easily be removed from end socket.

CLEANING AND INSPECTION

Immerse all parts in suitable cleaning solvent to loosen and remove all accumulated dirt and grease. Use stiff bristle brush and repeat immersions until all parts are clean.

Inspect all parts for evidence of excessive wear or corrosion. Inspect springs for loss of tension and broken coils. Discard seal and grease retainer. Replace defective and excessively worn parts wherever necessary.

ASSEMBLY

Key numbers in text refer to figure 8.

1. During assembly procedures, lubricate parts with lubricant recommended. Refer to LUBRICATION (SEC. 13) and Lubrication Chart.

2. Install bearing (8) into end socket. Install tapered stud (2).

3. In the order listed, install the following parts into end socket; grease retainer (9), stud seat (10), spring (13), plug (12), and lock wire (11).

4. If removed, install lubrication fitting and fill with recommended lubricant. Refer to LUBRICATION (SEC. 13) and Lubrication Chart.

5. Position dust cover washer (6), dust seal (5), dust cover shield (4), and shield spring (3) on tapered stud (2); then until ready to install the assembly on coach, install stud nut (1) to retain parts.

6. If socket end assembly was removed from extension, thread end socket on extension to a dimension of 20.66". Distance is measured from centerline of tapered stud to face of extension flange (fig. 6).

BOOSTER CYLINDER PISTON ROD END SOCKET

Power steering booster cylinder piston rod end socket is similar to booster cylinder extension end socket (fig. 8). Piston rod end socket threads directly on piston rod installed in booster cylinder assembly. Refer to "Booster Cylinder Extension and End Socket Overhaul" described earlier in this section for overhaul procedures.

BOOSTER CYLINDER PISTON ROD END SOCKET REPLACEMENT

REMOVAL

1. Remove cotter pin and stud nut attaching piston rod end socket stud to suspension support bracket. Using a puller, force socket stud from bracket.

2. Remove set screw; then loosen socket end clamp bolt. Thread socket assembly off piston rod.

3. Procedures required to overhaul booster cylinder piston rod end socket are the same as described previously under "Booster Cylinder Extension and End Socket Overhaul."

INSTALLATION

1. Compress booster cylinder assembly into fully retracted position; then thread booster cylin-

der piston rod end socket on piston rod to a dimension of 27.66. NOTE: Dimension is measured from centerline of end socket tapered stud to centerline of booster cylinder ball stud.

2. When booster cylinder is correctly adjusted, install set screw and clamp bolt. Tighten clamp bolt to torque listed in "Specifications." Stake set screw in three places.

3. Reinstall piston rod end socket to suspension support bracket. Tighten stud nut to torque listed in "Specifications." Secure nut with new cotter pin.

POWER STEERING DRAG LINK

Adjustable steering drag link assembly used with power steering is composed of two parts, drag link and end socket assembly (fig. 9). Drag link end socket assembly is roller-bearing type incorporating adjustable features which automatically compensate for normal wear. End socket assembly at Pitman arm end of drag link assembly threads on drag link and provides for length adjustment. End socket assembly is secured to drag link by a clamp bolt, nut, and lock washer. Opposite end of drag link engages booster cylinder ball stud and is secured by a stud nut and cotter pin.

MAINTENANCE

If steering linkage between the steering gear and front axle is out of adjustment, bent, twisted, or worn, steering action of coach will be seriously affected. At any time steering linkage parts are repaired, replaced, or adjusted, steering geometry and front wheel alignment must be checked.

Stud nuts at socket end and booster cylinder ball stud end of drag link must be kept tight or hole at ball stud end of drag link and hole in Pitman arm may become enlarged as a result of excessive looseness. Subsequent tightening of stud nuts may draw studs into holes so far that dust cover parts may be come damaged and result in premature replacement.

Drag link end socket is equipped with a lubrication fitting and should be lubricated at regular intervals.

DRAG LINK ADJUSTMENT

Drag link is adjusted properly when steering wheel is centered an equal number of turns between extreme right and left position with Pitman arm stops removed, and the front wheels are positioned straight-ahead. In this position the centerline of hole at drag link end of the Pitman arm will be to the right of centerline of coach when viewed from rear of front axle (fig. 6).

NOTE: Centerline of coach can be identified by prick punch marks on back of front axle beam.

1. If drag link needs adjustment, disconnect drag link at Pitman arm.

2. Loosen clamp bolt securing end socket to drag link. With steering gear centered and front wheels straight ahead, turn end socket on drag link as required to align center of end stud with center of hole in Pitman arm. Attach end socket to Pitman arm. Tighten stud nut to torque listed in "Specifications"; then install new cotter pin.

IMPORTANT: Booster cylinder end of drag link must be tilted to same plane as flange of booster cylinder ball stud body before clamp bolt at Pitman arm end socket is tightened. Rotate link if necessary; then tighten clamp bolt to torque listed in "Specifications."

DRAG LINK END SOCKET REPLACEMENT

Refer to "Drag Link Adjustment" preceding for preliminary procedures which will apply for replacement of drag link end socket. In addition to adjustment procedures, remove end socket from drag link.

DRAG LINK END SOCKET OVERHAUL

DISASSEMBLY

Key numbers in text refer to figure 9.

1. Remove outer dust seal cover (14), outer dust seal (13), and inner dust seal (12) from end socket tapered stud.

2. Position end socket assembly in a vise and press end plug (7) in against spring pressure far enough to remove end plug lock wire (8), by using a screwdriver to pry lock wire out of groove in

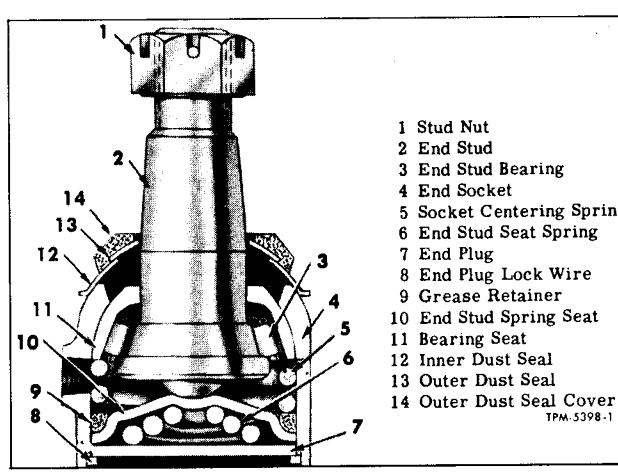


Figure 9—Power Steering Drag Link End Socket

end socket (4).

3. Remove end plug (7), end stud seat spring (6), end stud spring seat (10), grease retainer (9), socket centering spring (5), tapered end stud (2), end stud bearing (3), and end stud bearing seat (11) from drag link socket end (4).

CLEANING AND INSPECTION

Key numbers in text refer to figure 9.

1. Clean all parts except outer dust seal cover (14) thoroughly in cleaning solvent. Wipe or blow parts dry.

2. Inspect all parts for corrosion and excessive wear. Discard all parts not in good condition.

3. Check socket centering spring (5) and end stud seat spring (6) for free length, compressed length, distortion, or collapsed coils.

4. Inspect bearing rollers in end stud bearing assembly (3) for roughness or flaking. If rollers will not rotate freely in retainer, replace bearing assembly.

5. Discard dust seals, dust cover, and grease retainer.

ASSEMBLY

Key numbers in text refer to figure 9.

When assembling adjustable drag link end socket assembly, be sure all parts and working area are thoroughly clean. If dirt or foreign matter is allowed to get into drag link end socket assembly, excessive wear and premature replacement of parts will be the result. Lubricate each part with recommended lubricant. Refer to LUBRICATION (SEC. 13) and Lubrication Chart.

1. Position end stud bearing seat (11) and stud bearing (3) on tapered end stud.

2. Insert stud and bearing assembly into drag link end socket (4).

3. Position socket centering spring (5) in end socket (4) against end stud bearing seat (11).

4. Press new grease retainer (9) over end stud spring seat (10); then position retainer and seat in end socket (4).

5. Install end stud seat spring (6) and end plug (7) in end socket (4).

6. With end socket assembly positioned in vise, apply pressure against end plug to compress springs; then install end plug lock wire (8) in groove of end socket (4).

7. Position inner dust seal (12), outer dust seal (13), and outer dust seal cover (14) over threaded end of tapered end stud.

8. With drag link end socket assembly cleaned, inspected, and repaired, assemble to drag link and adjust as directed previously under "Drag Link Adjustment."

POWER STEERING HYDRAULIC PUMP

The power steering pump (fig. 10) is a vane type, hydraulic unit which supplies hydraulic power for operation of the steering booster cylinder at front axle. Pump is mounted at rear of engine (fig. 2), and is driven by the blower drive shaft through a coupling (fig. 11). The fluid reservoir and filter is remotely mounted and is connected to the hydraulic system by hoses (fig. 2).

OPERATION

PUMP OPERATION

Pumps are composed principally of a pressure plate, ring, rotor, vanes, and wear plate. (Refer to fig. 10.) The rotor is driven within the pump ring by a drive shaft, coupled to a power source. As the rotor speed increases, centrifugal action causes the vanes to follow the cam-shaped contour of the pump ring (fig. 12). System pressure, fed behind the vanes, assures sealing contact of vanes on ring contour during normal operation.

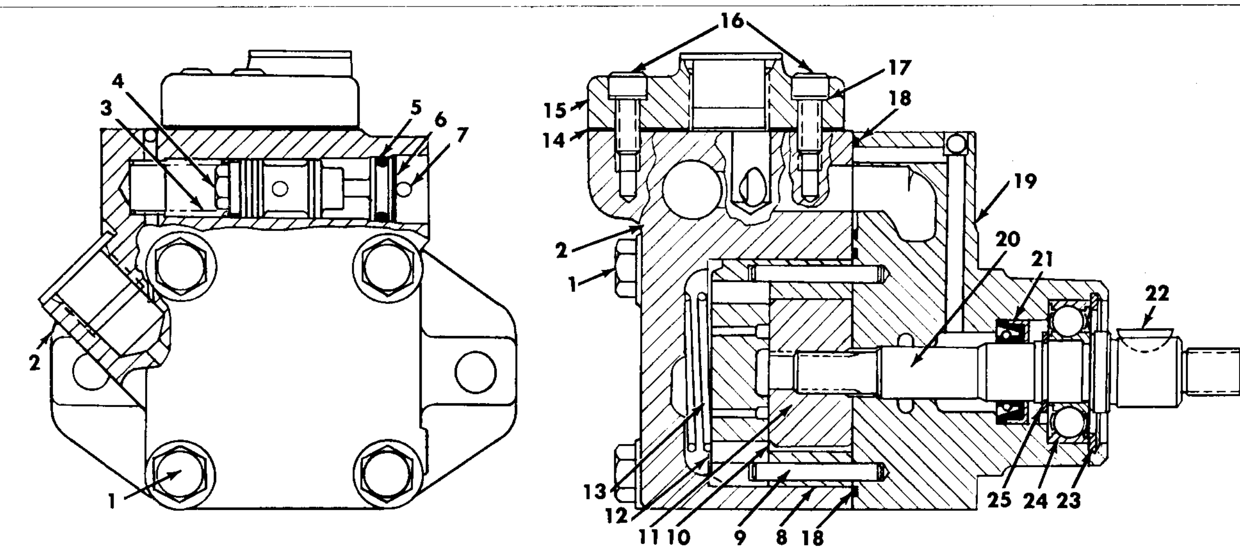
The ring is shaped so that two opposing pumping chambers are formed. Radial movement of the vanes, and rotation of the rotor, causes the chamber area between vanes to increase in size at the inlet (large diameter) section of the ring. This results in a low pressure, or vacuum in the chamber. This pressure differential causes oil to flow into the inlet, where it is trapped between the rotating vanes and is forced, through porting in the pressure plate, to discharge into the system as the chamber size decreases at the pressure quadrant (small diameter) of the ring.

FLOW CONTROL AND RELIEF VALVE

Maximum pump delivery and maximum system pressure are determined by the integral flow control and relief valve in a special outlet cover used on pumps. This feature is illustrated schematically in figure 13. An orifice in the cover limits maximum flow. A pilot-operated type relief valve shifts to divert excess fluid delivery to reservoir, thus limiting the system pressure to a prescribed maximum.

View "A" shows the condition when the total pump delivery can be passed through the orifice. This condition usually occurs only at low drive speeds. The large spring chamber is connected to the pressure port through an orifice. Pressure in this chamber equalizes pressure at the other end of the relief valve spool and the light spring holds the spool closed. Pump delivery is blocked from the reservoir port by the spool land.

When pump delivery is more than the flow rate determined by the orifice plug, a pressure build-up forces the spool open against the light



1 Cap Screw
2 Cover
3 Flow Control Spring
4 Relief Valve
5 O-Ring
6 Relief Valve Plug
7 Retaining Pin
8 Pump Ring
9 Locating Pins
10 Vane
11 Rotor
12 Pressure Plate
13 Pressure Plate Spring
14 Manifold Gasket
15 Manifold
16 Manifold Cap Screws
17 Copper Washer (1 only)
18 O-Rings
19 Pump Body
20 Pump Shaft
21 Pump Shaft Seal
22 Woodruff Key
23 Retaining Ring
24 Ball Bearing
25 Retaining Ring

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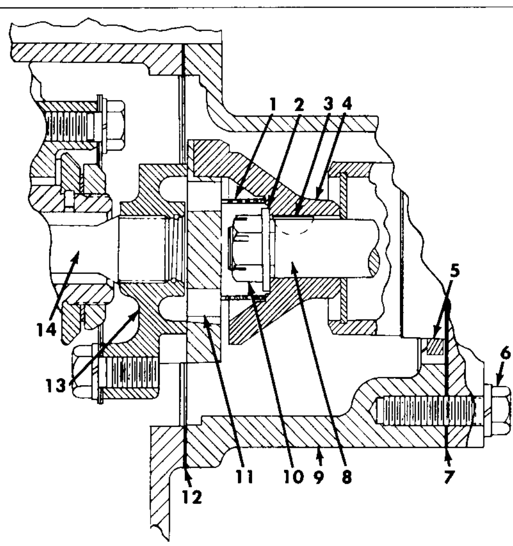
Figure 10—Sectional View of Power Steering Hydraulic Pump



1 Coupling Spring
2 Plain Washer
3 Driven Hub Key
4 Power Steering Pump Driven Hub
5 Pump to Adapter Pilot Ring
6 Pump to Adapter Attaching Bolt
7 Gasket
8 Pump Drive Shaft
9 Adapter
10 Nut
11 Pump Drive Coupling
12 Gasket
13 Driving Hub
14 Blower Drive Shaft

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Figure 11—Power Steering Pump Drive

spring. Excess fluid is throttled past the spool to the reservoir port as shown in View "B."

If pressure in the system builds up to the relief valve setting (View "C"), the pilot poppet is forced off its seat. Fluid in the large spring chamber flows through the spool and out to reservoir. This flow causes a pressure differential on the spool, shifting it against the light spring. All pump delivery is thus permitted to flow to reservoir.

OPERATING INSTRUCTIONS

Normally, these pumps require no manual priming. However, it is essential that, after starting, a minimum drive speed of 600 RPM be held until the pump picks up its prime and pressure is

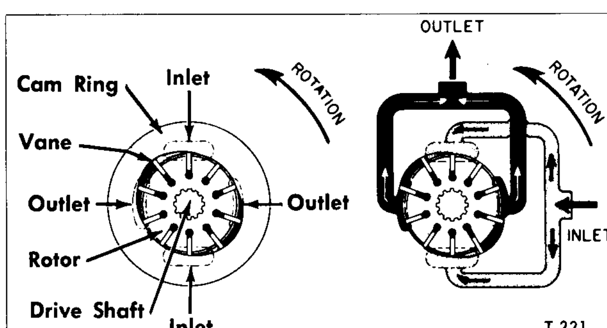


Figure 12—Operation and Fluid Flow

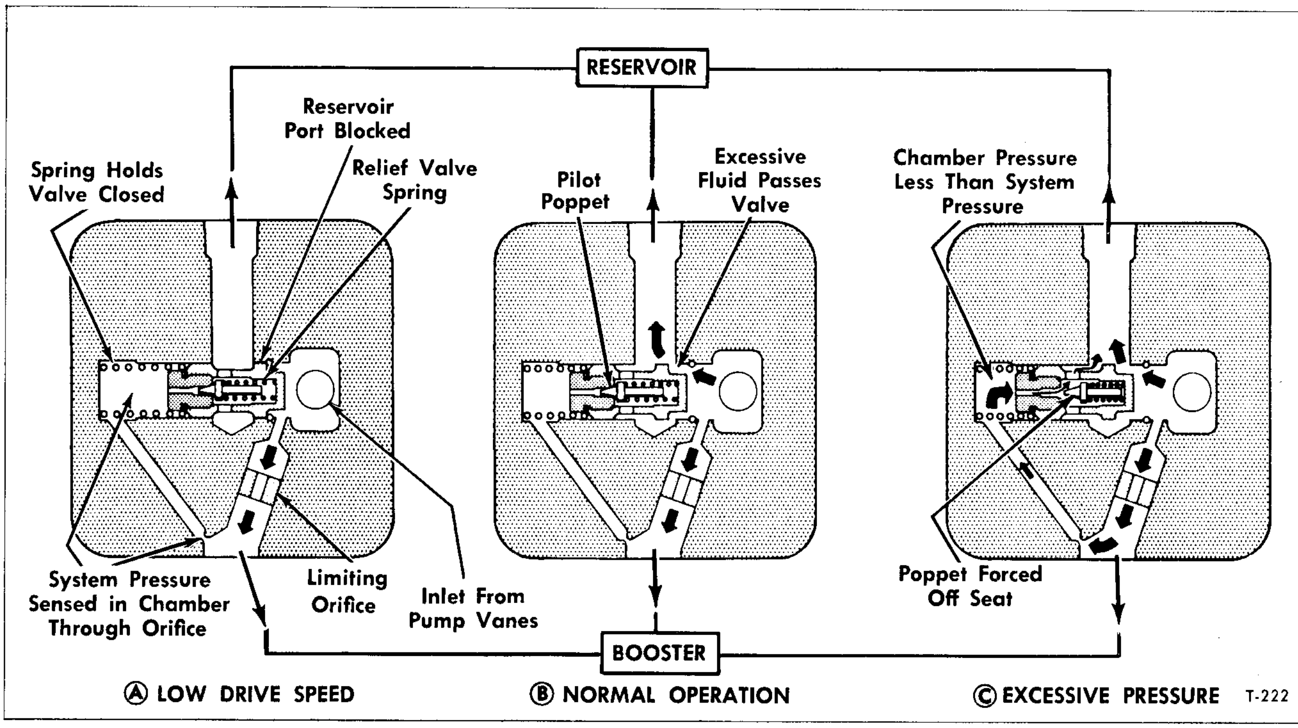


Figure 13—Hydraulic Pump Flow Control and Relief Valve Operation

built up in the system. Failure to observe the above precaution can result in scoring and possible seizure of the pump due to a lack of oil for lubrication.

MALFUNCTION

For diagnosis and remedy of trouble relative to power steering hydraulic pump see "Hydraulic Pump Trouble Shooting Chart."

HYDRAULIC FLUID RECOMMENDATIONS

Refer to LUBRICATION (SEC. 13) for type of fluid and intervals of service required for the power steering system.

HYDRAULIC PUMP REPLACEMENT

REMOVAL

Key numbers in text refer to figure 11.

1. Place a clean pan under power steering pump pressure and return flexible lines and pump ports to catch hydraulic fluid; then remove lines from pump by unscrewing fittings.
2. Remove bolts, nuts, and lock washers attaching power steering pump and adapter assembly to engine flywheel housing.
3. Using care to avoid dropping coupling ring (11) and coupling spring (1), remove pump and adapter assembly from engine.
4. Remove coupling ring (11) and coupling spring (1); then remove adapter to housing gasket (12). Discard gasket.
5. Remove lock nut (10) and plain washer (2) attaching driven hub (4) to pump drive shaft (8).
6. Remove two bolts (6) and lock washers attaching pump to adapter.
7. Remove adapter (9), adapter pilot ring (5), and gasket (7) from pump. Discard gasket.

INSTALLATION

Key numbers in text refer to figure 11.

1. If previously removed, install Woodruff key (3) in slot of pump drive shaft (8).
2. Position pump driven hub (4) on pump drive shaft (8), aligning Woodruff key in drive shaft with slot in hub (4).
3. Install plain washer (2) and lock nut (10) attaching pump driven hub (4) to pump drive shaft (8).
4. Position adapter pilot ring (5) in the adapter (9); then attach adapter and new gasket (7) to power steering pump with two bolts and washers.
5. Install coupling spring (1) and coupling ring (11) in pump adapter, engaging prongs of driven hub (4) with slots in coupling ring (11).
6. Using new adapter to flywheel housing gasket (12), position pump and adapter assembly to flywheel housing, engaging prongs of driving hub (13) with slots in coupling ring (11).
7. Install adapter to flywheel housing, attaching with bolts, nuts, and lock washers. Tighten securely.
8. Connect power steering pump pressure and

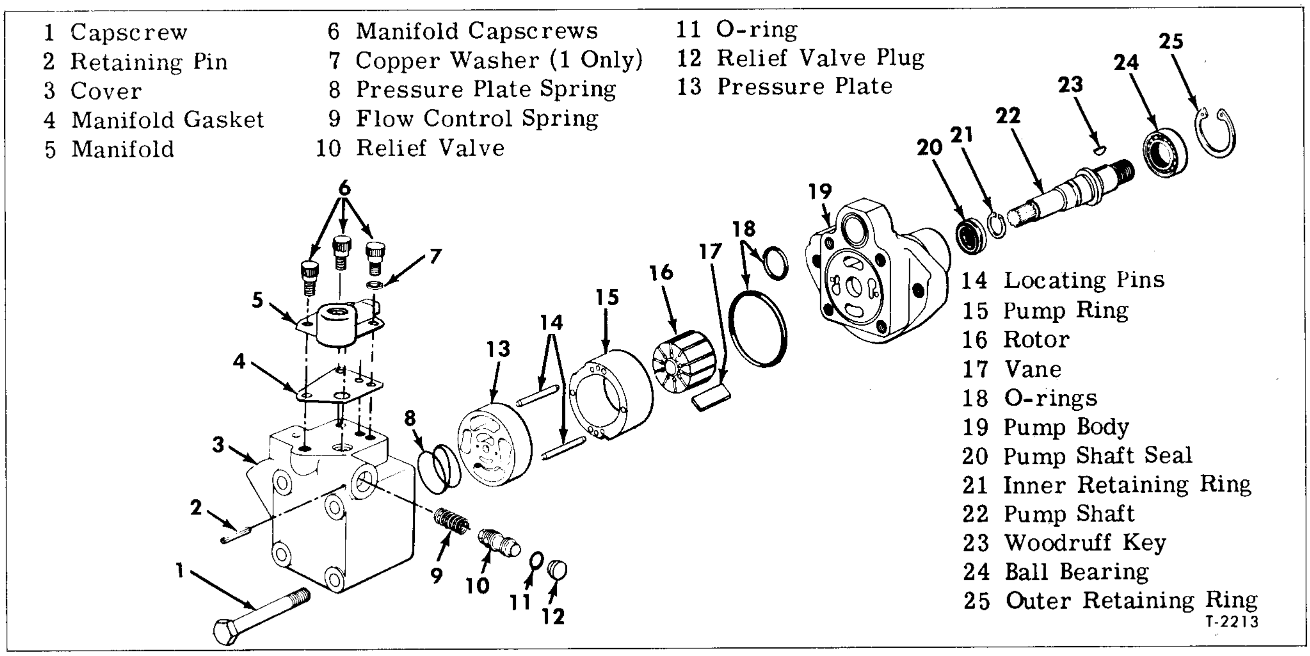


Figure 14—Power Steering Hydraulic Pump Components

return flexible lines to pump. Tighten fittings firmly.

9. Refill power steering hydraulic system and bleed system as described previously under "Bleeding Power Steering System."

HYDRAULIC PUMP OVERHAUL

Overhaul of power steering hydraulic pump must be undertaken in clean working area with pump removed from coach engine. It is important that overhaul procedures described in the following text be carefully followed.

DISASSEMBLY

Key numbers in text refer to figure 14.

1. Using a suitable cleaning solvent, thoroughly clean the exterior of the hydraulic pump to prevent entry of dirt or other foreign matter into the pump during overhaul procedures.
2. Remove three manifold cap screws (6) and copper washer (7). Remove manifold (5). Remove and discard manifold gasket (4).
3. Remove cover mounting cap screws (1) and separate the cover (3) from the pump body (19).
4. Remove pressure plate spring (8) and pressure plate (13).
5. Remove pump ring (15), locating pins (14), rotor (16) and vanes (17), and the two O-rings (18).
6. Mount the cover (3) in a vise. Drive out retaining pin (2) with a suitable punch. Protect the relief valve plug and subassembly against falling from bore. Work the plug (12), relief valve (10) and spring (9) from the bore.

NOTE: Access to the relief valve plug and subassembly may be gained through the large chamfered hole which leads to relief valve bore from inside the cover.

7. Remove outer retaining ring (25) from pump body (19).
8. Support the shaft end of the pump body (19) in a two inch straight pipe coupling and, using an arbor press, remove the shaft (22). The shaft assembly should drop through a slot in the press table so the shaft will not be damaged.
9. Remove inner retaining ring (21) and ball bearing (24) from shaft (19).
10. Press shaft seal (20) from pump body (19).

INSPECTION

NOTE: Wash all parts, except seals, in clear mineral solvent and lay them aside for inspection. Replace all old seals and O-rings at reassembly.

1. Ring, Rotor, Vanes, Pressure Plate, Body - Inspect the surfaces of all parts which are subject to wear. Light scoring may be removed from the faces of the body or wear plate with crocus cloth (by placing the cloth on a flat surface), medium stone or by lapping. Check the edges of vanes for wear. Vanes must not have excessive play in slots or burrs on edges. Replace if necessary. Check each rotor slot for sticky vanes or wear. Vanes should drop in rotor slots by their own weight when both slot and vane are dry.

2. Relief Valve - Insert valve in its bore in pump cover. There should be no binding. Check valve and bore for excessive wear and scoring.

Replace if necessary.

3. Bearing - Wash bearing thoroughly. Inspect and replace bearing if worn or damaged.

4. Shaft and Seal - Replace the shaft seal at each overhaul to prevent oil leakage. Check the drive shaft oil seal diameter for wear and scoring. Do not install a new seal on a shaft which is worn or damaged at the oil seal diameter. Replace the shaft if worn. Stone and polish the sharp edges on the shaft to prevent damage to the seal.

5. Body and Cover - Stone all mating surfaces with a medium stone to remove all burrs and sharp edges. Rewash all parts after stoning.

ASSEMBLY

NOTE: Immerse all parts in clean hydraulic oil to facilitate reassembly. Refer to figure 14.

1. Press shaft seal (20) in pump body (19).
2. Press ball bearing (24) onto shaft, and position inner retaining ring (21) on shaft against bearing.
3. Insert shaft (22) in pump body (19), and insert outer retaining ring in body at shaft end.
5. Install locating pins (14) in pump body (19). Install pump ring (15) over pins in correct direction of rotation.
6. Position rotor (16) in pump ring (15) with chamfered edge of splined hole "in" or toward pump body (19). The chamfer facilitates assembly.
7. Install vanes (17) with their radius edge toward the inner ring contour.
8. Oil the pump ring (15) and rotor (16) with clean hydraulic oil and install pressure plate (13).
9. Install O-rings (18). Install pressure plate spring (8) and cover (3). Tighten cover screws (1) to torque listed in "Specifications."
10. Install pressure compensating spring (9) in relief valve bore. Insert valve assembly (10) with the hex toward the spring. Install plug (12) with O-ring (11) in bore and hold it in position while driving a new retaining pin (2).
11. Position new manifold gasket (4) and manifold (5) on pump cover and secure manifold to pump body with screws (6). Copper washer (7) is used on screw where tapped hole enters oil passage. Tighten screws to torque listed in "Specifications."

HYDRAULIC PUMP TROUBLESHOOTING CHART

TROUBLE	PROBABLE CAUSE	REMEDY
PUMP NOT DELIVERING OIL	DRIVEN IN WRONG DIRECTION OF ROTATION.	Check direction of pump shaft rotation.
	PUMP DRIVE SHAFT DISENGAGED OR SHEARED.	Remove pump; determine damage to cartridge parts (see disassembly instructions) replace sheared shaft and needed parts.
	FLOW CONTROL VALVE STUCK OPEN.	Disassemble pump and wash control valve in a clean solvent. Return valve to its bore and slide it back and forth. No stickniness in movement should occur. If a gritty feeling is noted on the valve O.D. it may be polished with crocus cloth. Avoid removal of excess material or rounding of valve edges during this operation. Do not attempt to polish the valve bore. Wash all parts before reassembly of pump. Flush entire system thoroughly and fill with clean oil.
	VANE OR VANES STUCK IN ROTOR SLOTS.	Disassemble pump, examine rotor slots for dirt, grime or small metal chips. Clean rotor and vanes, in a good grade solvent (mineral spirits or kerosene) reassemble parts and check for free vane movement.

HYDRAULIC PUMP TROUBLESHOOTING CHART (CONT'D)

TROUBLE	PROBABLE CAUSE	REMEDY
PUMP NOT DELIVERING OIL (Cont'd.)	OIL VISCOSITY TOO HEAVY TO PICK UP PRIME.	Use fluid of the proper viscosity as recommended.
	PUMP INTAKE PARTIALLY BLOCKED.	Drain system completely; flush to clear pump passages. Flush and refill system with clean oil as per recommendations.
	AIR VENT FOR RESERVOIR CLOGGED OR DIRTY STRAINER.	Remove filler cap and clean air vent slot. Check filter or strainer in tank for clogged condition. Drain, flush and add clean oil to system if strainer was clogged.
PUMP MAKING NOISE	RESTRICTED OR PARTIALLY CLOGGED INTAKE LINE OR CLOGGED FILTER.	Pump must receive intake oil freely or cavitation will result. Drain system, and clean intake line and strainers. Add new oil and strain by recommended procedures.
	AIR LEAK AT PUMP INTAKE PIPING JOINTS OR PUMP SHAFT SEAL.	Test by pouring oil on joints and around drive shaft. Listen for change in operation. Tighten joints affected and replace pump drive shaft seal according to service instructions as outlined.
	COUPLING MISALIGNMENT.	Re-align and replace oil seal and bearings if damaged by shaft misalignment.
	RESERVOIR OR MANIFOLD SEAL LEAKAGE.	Leakage between manifold or reservoir at replenishing hole due to O-ring damage. Reservoir inlet tube to pump cover O-ring should be carefully examined for damage such as cuts, nicks, or dirt.

POWER STEERING FLUID RESERVOIR AND FILTER

FLUID RESERVOIR

Power steering fluid reservoir and filter assembly is bracket-mounted in upper right-hand corner of engine compartment (fig. 2).

It is recommended for inter-city operation, that every 100,000 miles (or 6 months, whichever occurs first), dependent upon operating conditions, the fluid reservoir cover should be removed and element replaced. Any time power steering reservoir has been serviced, power steering hydraulic system should be bled.

SERVICING RESERVOIR FILTER (Fig. 15)

1. Disconnect hose from reservoir outlet (12) and drain fluid.
2. Remove filler cap (2) and dipstick (1) assembly.
3. Remove cover bolt (3) and gasket (4).

CAUTION: Hold cover (5) so compression of spring (7) will not cause it to fly off.

4. Remove cover (5) and hold-down spring (7).
5. Remove basket-type filter screen and washer assembly (8).
6. Remove filter element cartridge (9).

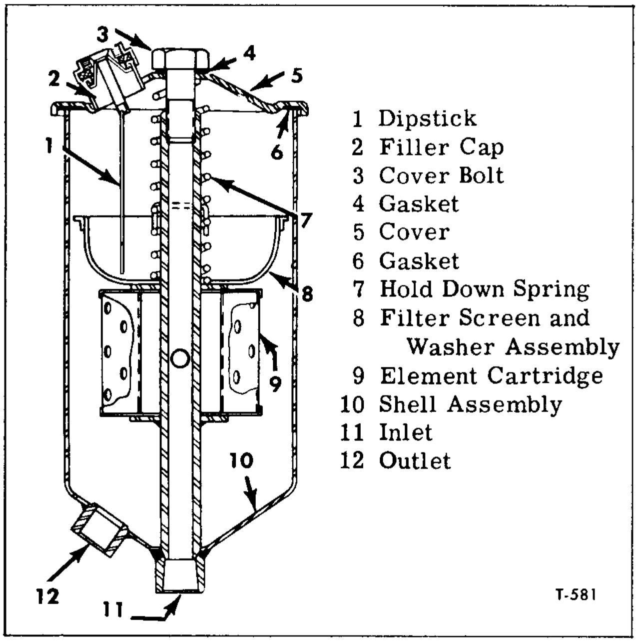


Figure 15—Power Steering Reservoir and Filter

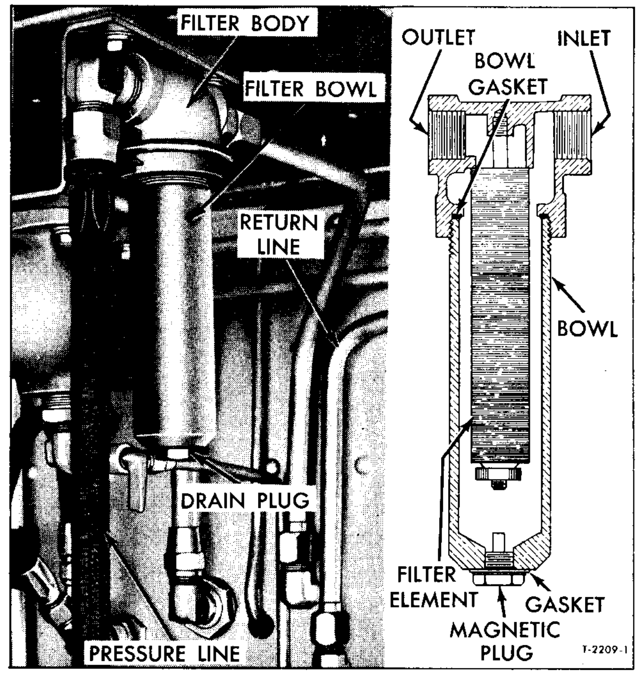


Figure 16—Fluid Filter Installed

7. Rinse filler cap (2) in suitable solvent to remove accumulated dirt. If unable to clean satisfactorily, replace with new cap and dipstick assembly.

8. Wipe out reservoir shell (10) with dry, clean, lint-free cloth.

9. Install new element cartridge (9).

10. Wash filter screen and washer assembly (8) in suitable solvent, dry thoroughly and install in shell (10).

11. Install hold-down spring (7).

12. Install new gasket (6) in cover (5) and place cover on shell.

13. Install new gasket (4) on cover bolt (3) and install bolt to secure cover.

14. Fill reservoir with fluid and bleed system as previously described.

15. Install filler cap (2) and dipstick (1) assembly.

FLUID LINE FILTER

Power steering fluid filter assembly is bracket-mounted to engine bulkhead (fig. 2).

At regular lubrication intervals, fluid filter bowl should be removed and element and magnetic plug cleaned. Any time power steering fluid filter has been serviced, power steering hydraulic system should be bled. Refer to "Bleeding Power Steering Hydraulic System" explained earlier in this section.

SERVICING FLUID LINE FILTER
(Refer to Fig. 16)

NOTE: The fluid line filter assembly can be serviced without removing complete assembly from coach.

1. Using a wrench on wrench flats, turn filter bowl out of threads of filter head.

2. Remove and discard filter bowl gasket.

3. With a small wrench, unscrew filter element assembly from filter head. Use care to avoid damage to element. Clean parts, using cleaning solvent and compressed air.

4. Remove fluid line filter magnetic drain plug from bottom of filter bowl. Clean all metallic material from plug magnets.

5. Reassemble filter; then bleed hydraulic system as directed earlier under "Bleeding Power Steering Hydraulic System."

SPECIFICATIONS

HYDRAULIC PUMP

Make....Vickers
Model....VTM27-50-40-10-MJ-L1-12-S4
Type....Hydraulic Vane
Capacity....4.0 Gal. per Minute at 1200 R.P.M.

PUMP ROTOR
Width....0.9210″-0.9212″
Outside Diameter....1.5930″-1.5980″
Number Vane Slots....10
Vane Slot Width....0.0780″-0.0785″

ROTOR VANES
Quantity....10
Thickness....0.0770″-0.0775″
Width....0.3430″
Length....0.9206″-0.9209″

OUTER BEARING
Type....Ball
Outside Diameter....1.5743″-1.5748″
Inside Diameter....0.6690″-0.6693″
Width....0.467″-0.472″
Diameter of Ball....5/16″
Number of Balls....7

FLOW CONTROL VALVE
Opening Pressure....1000 psi (±50)

FLOW CONTROL VALVE SPRING
Free Length....2.5470″
Compressed Length Under 6.25 lbs....1.2970″
8.2 lbs....0.9060″

PUMP SHAFT
Diameter at Ball Bearing....0.6693″-0.6697″
Diameter at Oil Seal....0.6250″
Length of Spline....0.6250″
Number of Splines....14

POWER STEERING BOOSTER CYLINDER

Make....Vickers
Model....S20A22-000XNN12N-11-011
Type....Hydraulic

	Retracted	Extended
Length (end of push rod w/o socket to center of control stud)	25.406″	37.500″

STROKE....12 3/32″
Booster Cylinder Extension and End Socket Adjusted Length (Centerline of End Socket Tapered Stud to Outside Edge of Flange)....20.66″

VALVE CENTERING SPRING
Free Length....1.437″
Compressed Length Under 75 lbs....1.062″
Compressed Length Under 100 lbs....0.937″

STEERING DRAG LINK

Type....Adjustable Length
Length—Stud Centers....Approx. 9.98″

SPRINGS
Stud Seat Spring
Free Length....0.750″
Compressed Length Under 350-400 lbs....0.500″

SOCKET CENTERING SPRING
Free Length....1.250″
Compressed Length Under 30 lbs....0.875″

RESERVOIR AND FILTER

Element....Disposable Cartridge

CARTRIDGE HOLD DOWN SPRING
Free Length....5.38″
Compressed Length Under 12-15 lbs....4.62″

TORQUE SPECIFICATIONS

Location	Ft.-Lbs.
Cover to Pump Body Bolt	25-30
Booster Cylinder Flange to Extension Flange Bolts	40-50
Drag Link to Booster Cylinder Ball Stud Nut and advance to nearest cotter pin hole.	150
Piston Rod End Socket Stud to Support Bracket Stud Nut and advance to nearest cotter pin hole.	150
Extension End Socket Stud to Steering Arm Nut and advance to nearest cotter pin hole.	150
Drag Link Stud to Pitman Arm Nut and advance to nearest cotter pin hole.	125-150
Piston Rod End Socket Clamp Bolt—Nut	45-55
Extension End Socket Clamp Bolt—Nut	45-55
Drag Link Clamp Bolt—Nut	45-55
Pump Manifold Capscrews	6-8
Pump to Adapter Bolt	25-30
Pump Drive Shaft Lock Nut	60-70
Booster Cylinder to Ball Stud Hsg. Nuts (Cross Torque)	30-40
Booster Cylinder Support Bracket Nuts	80-90
Pitman Arm Stop Bolts	60-65

Refer to LUBRICATION (SEC. 13) for steering system lubrication points and intervals of application.

Use only the fluid recommended in LUBRICATION (SEC. 13) in Power Steering System.

Transmission

SPICER 4-SPEED MECHANICAL (MODEL 7145VK)

DESCRIPTION

GENERAL

Transmission is four-speed mechanical type mounted directly to engine. Power input is through 63-degree angle drive gears which are enclosed in a portion of the clutch housing. Clutch housing, transmission case and control cover are of cast aluminum alloy. Cast iron inserts are employed where additional strength is required. Angle drive gears are spiral bevel type. All mainshaft, countershaft and reverse idler gears are constant mesh type with helical teeth.

The transmission gears are shifted manually through use of gearshift lever located at right of driver's seat and connected to levers on transmission by rods and bell cranks (figs. 4 and 5).

Shift forks in transmission cover (fig. 18) engage sliding clutches (fig. 16) and the clutches lock gears to respective shafts to provide the power train for each speed.

Transmission lubricant is contained in reservoir on bottom of transmission case. Lubricant is circulated to various points by a gear type pump mounted inside clutch housing (fig. 9).

The drive pinion has drilled passages to carry lubricant to clutch components and pilot bearing (bushing) at engine flywheel. Additional information on lubrication system and pump is included later under "Lubrication System Maintenance."

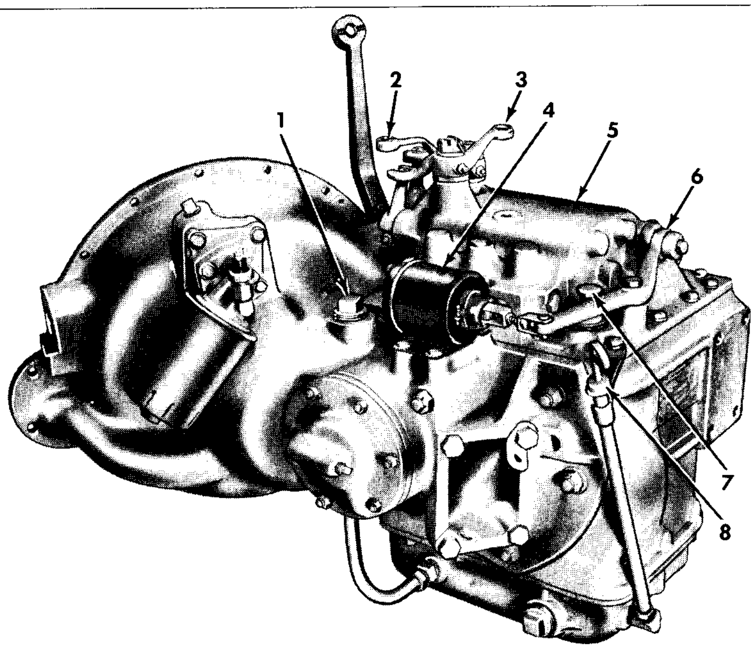
The terms "Front" and "Rear" as used in this section do not refer to mounted position of transmission in coach. "Front" refers to the input or engine end of transmission while "Rear" refers to output or propeller shaft end of transmission.

Figure 1 is a view of transmission assembly.

The key numbers used in following descriptions refer to figure 17 unless otherwise indicated.

MAINSHAFT, GEARS, AND BEARINGS

Front end of mainshaft (39) is supported by pilot bearing (14) located in pocket in drive gear (15). Mainshaft rear bearings (33 and 34) which take endwise thrust and carry radial load are tapered roller type, installed in retainer (46). Rear bearing cap (36) locks bearing outer cup in retainer. Lip of oil seal (38) in bearing cap (36) prevents lubricant leakage and seals out dirt. Speedometer drive gear (37) contacts inner race of bearing (34) and gear is locked in place by yoke assembly (43). Speedometer driven gear (45) is installed in bearing cap (36) and is held in place by a sleeve.



1 Filler Plug
2 1st, 2nd, and Reverse Lever
3 3rd and 4th Lever
4 Reverse Solenoid
5 Cover Assembly
6 Reverse Solenoid Lever
7 Breather Assembly
8 Oil Level Dipstick

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Figure 1—Transmission Assembly

17

Mainshaft 3rd and 4th speed clutch gear (86) is mounted on splined portion of mainshaft and held in place with mainshaft gear retaining nut (17) and lock (87). First and 2nd speed clutch gear is integral with mainshaft.

Mainshaft 1st (21), 2nd (19), and 3rd (18) speed constant mesh gears are each mounted on double row needle bearings. Rows of bearings are separated by spacers.

Oil tube (13) in drive gear (15) supplies lubricant to drilled passage in mainshaft from which lubricant is distributed to bearings and to speedometer gears. Sliding clutch (27) is shifted to provide 1st and second speeds and sliding clutch (85) is shifted to provide 3rd and 4th speeds. Figure 16 shows view of gears in transmission case.

COUNTERSHAFT AND GEARS

Countershaft (63) is supported at rear by straight roller bearing (57) held on shaft with two lock nuts (50 and 58) and nut lock (53). Front end of shaft is supported in countershaft front roller bearing (84) which is prevented from coming out of case by clutch housing (88). Inner race of roller bearing (84) is held on shaft by countershaft nut (83) and retaining washer (82).

Countershaft drive gear (77) and countershaft 3rd speed gear (74) are keyed to shaft and separated by spacer (76). Countershaft 2nd speed gear (64) and countershaft clutch gear are integral with shaft.

Countershaft 1st speed gear (60) is not keyed to shaft, but is carried on bronze bushing (61) and is driven by countershaft sliding clutch (62) carried on countershaft clutch gear. Countershaft sliding clutch is operated by reverse shift fork and is engaged in all forward speeds.

REVERSE IDLER GEAR

Reverse idler driving and driven gears (69 and 73) are mounted on roller bearings, with two rows of bearings in each gear separated by spacers.

Reverse idler gears are separate, revolving independently of each other in all forward speeds. Reverse idler driven gear is in constant mesh with countershaft 2nd speed gear (64) and reverse idler driven gear (69) is in constant mesh with mainshaft 1st speed gear (21). Reverse idler sliding clutch (71) is carried on hub of reverse idler driving gear, and engages both gears during reverse operation. Thrust washers (67) are installed between respective gears and adjacent portion of transmission case.

DRIVE GEAR AND BEARINGS

Drive gear (15) is supported at transmission case by roller bearing assembly (12). Bearing is held in place by retainer (10) which is bolted to transmission case. Seal (11) prevents leakage between retainer and clutch housing (88). Tapered roller bearings are used at outer end of drive gear. Outer bearings are adjustable, and shims (4) are used to provide proper contact between bevel pinion gear and bevel drive gear (89) keyed to shaft which is integral with drive gear (15). Oil tube (94) carries oil supplied by pump to lubrication passage in drive gear.

BEVEL GEARS AND BEARINGS

Key numbers in text refer to figure 15 unless otherwise indicated.

Bevel drive gear (18) is installed on front end of drive gear (27). Keys in drive gear shaft are engaged with keyway in gear. Bevel drive gear (18) is driven by drive pinion (17).

Drive pinion (5) is supported at front end by pilot bearing in engine flywheel. At clutch housing (33) drive pinion shaft (5) is mounted on opposed tapered roller bearings which are installed in retainer (37). Spacer (36) and shims provide means for adjusting the bearing pre-load. Nut (40) holds bearings in place on drive pinion. Oil tube (32) pressed into housing (33) carries lubricant to drilled passage in drive pinion to lubricate drive pinion bearings. Shims (19 and 41) are used to adjust gear backlash and gear tooth contact.

COVER, SHIFT LEVERS, AND FORKS

Key numbers refer to figure 18 unless otherwise indicated.

External levers and fingers at transmission cover (14) are operated by transmission gearshift lever and linkage. Inner fingers (7 and 12) engage notches in shift forks. Three shift forks (1, 10, and 13) are clamped to shift rods (15, 16, and 17). Sleeves (5 and 9) on shift rods prevent overshifting, and spring-loaded poppet balls in cover engage notches in top of shift rods to lock the rods into proper position. Interlocks prevent lock-up of transmission by preventing engagement of two gears at once.

Reverse solenoid and lever (4 and 6, fig. 1) move shaft (4) endwise to engage inner finger (12) with notch in fork (13) when shifting into reverse. Spring (11) returns finger (12) to notch in 1st and 2nd shift fork when shifting transmission out of reverse. A breather assembly (7, fig. 1) is installed in transmission cover.

LUBRICATION SYSTEM

Lubricant which lubricates transmission and clutch is contained in oil reservoir bolted on bottom of transmission case. The pump is mounted inside clutch housing and is gear driven. Oil from reservoir is drawn to pump through suction line, and is discharged through line to oil filter adapter and oil filter assembly (fig. 2). Located in oil filter adapter is a spring-loaded pressure regulator valve

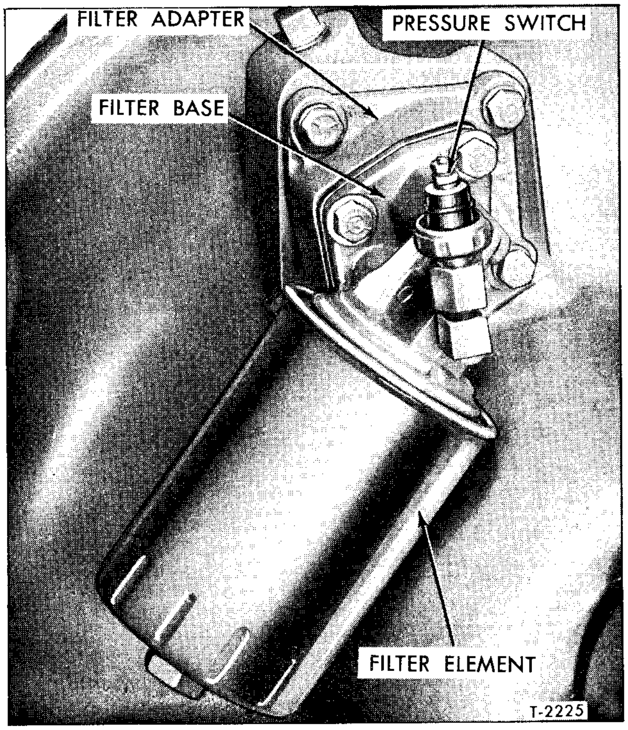


Figure 2—Oil Filter and Pressure Switch Installed

which maintains pressure at switch at low engine speed. Lubricant is directed through oil passages and transfer tube in clutch housing to lubricate transmission bearings and gears, also clutch components.

The drive pinion shaft is drilled lengthwise and clutch components are lubricated by oil pumped through oil passage in drive pinion. A restricted fitting is used in front (engine) end of drive pinion shaft. Lubricant drains from clutch housing to transmission housing and down through screen (75, fig. 17) into reservoir.

Filter element is disposable type which is screwed onto threaded nipple on filter mounting base. A by-pass valve is provided in filter adapter to allow oil to by-pass the filter element and continue to lubricate transmission and clutch parts if filter element becomes clogged.

A pressure switch (fig. 2), mounted on oil filter base, completes an electrical circuit and lights a tell-tale lamp on instrument panel to warn driver in case transmission oil pressure drops below safe operating pressure (1-1/2 to 2-1/2 psi).

TRANSMISSION CONTROLS

Selection of transmission gear is made by conventional shifting lever. Gearshift lever is mounted in a tower attached under floor near driver's seat. Two shift rails in base of gearshift lever tower are connected with control rods which run from front to rear of coach below floor. Adjustable clevises are provided at both ends of forward rods and also where rear rods are connected with levers at bulkheads.

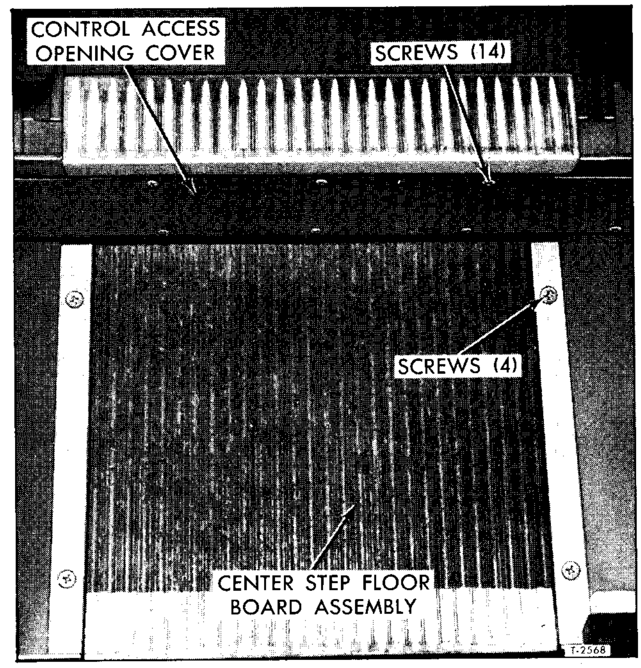


Figure 3—Control Access Cover Installation

When shift is made for any one of four forward speeds, the movement of shift lever is transmitted to transmission through various rods, levers and bell cranks (fig. 4).

Control rods (fig. 4) pass through looms which are supported to bulkheads and supports with rubber grommets. Bellows-type seals are used at each end of loom to prevent entry of grit and dirt.

Reverse solenoid is mounted on transmission and connected to lever (fig. 7) which moves 1st, 2nd, and reverse shaft endwise. Solenoid is energized by a button type switch on panel at left of driver which operates reverse relay located in engine compartment apparatus box.

Relay completes circuit to the reverse solenoid. When solenoid is energized, solenoid plunger which is linked to reverse lever (8, fig. 7) pulls on reverse lever and forces shift finger shaft endwise to disengage inner finger from notch in 1st and 2nd fork and engage finger with reverse shift fork. This action can take place only when gearshift lever is in the 1st speed position. Refer to figure 4 for shift diagram.

MAINTENANCE

CONTROL ROD ADJUSTMENT

Key numbers in text refer to figure 4, except as otherwise indicated.

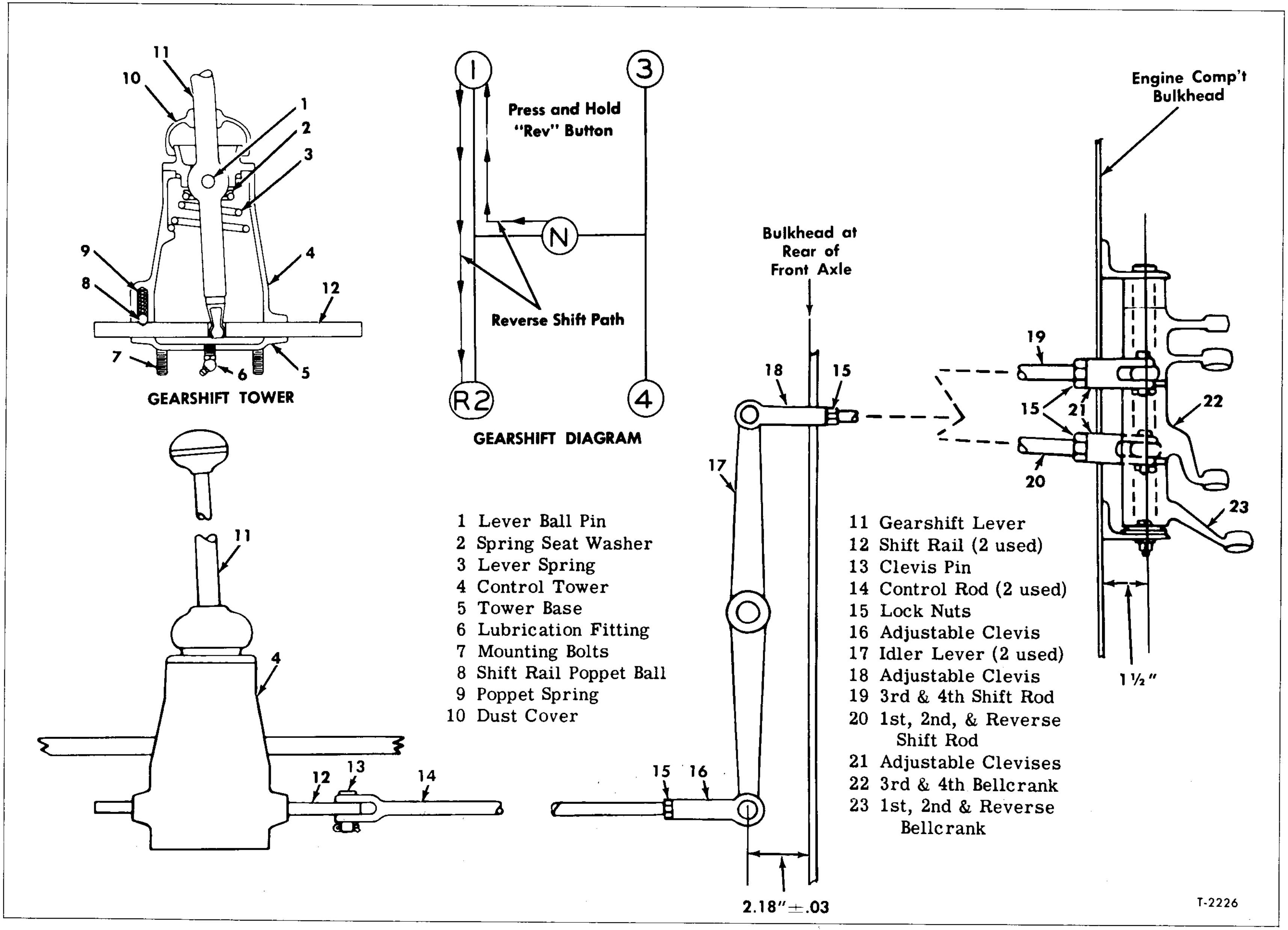
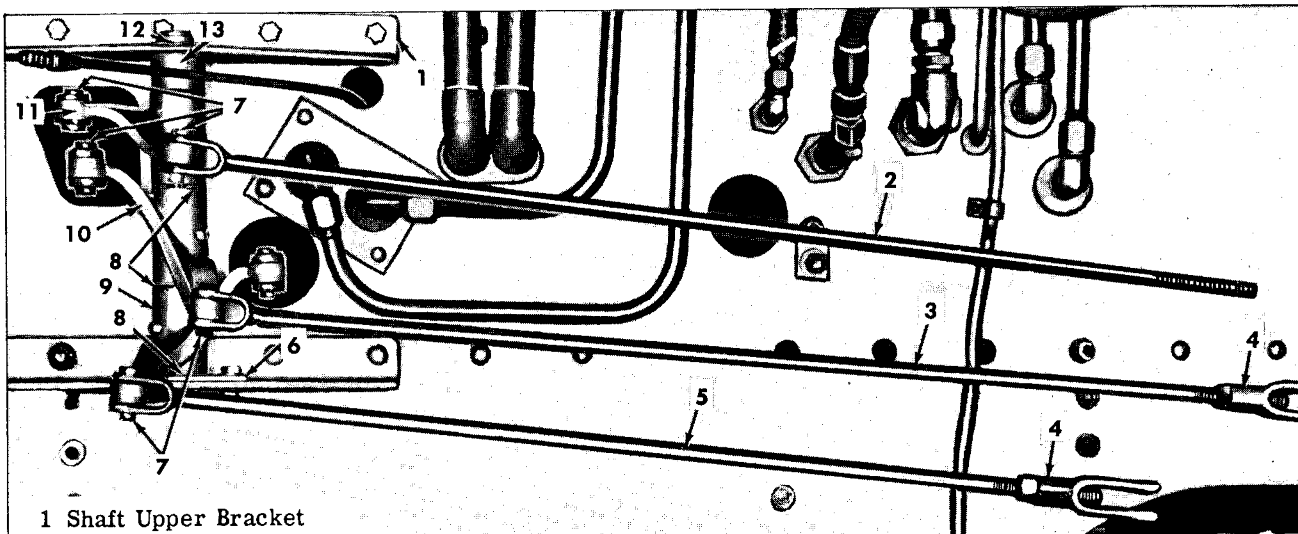


Figure 4—Transmission Controls



1 Shaft Upper Bracket
2 Clutch Control Rod
3 3rd and 4th Shift Rod
4 Clevises
5 1st, 2nd, and Rev. Shift Rod
6 Shaft and Lower Bracket Assy.
7 Clevis Pins
8 Thrust Washers
9 1st, 2nd and Rev. Idler Lever
10 3rd and 4th Idler Lever
11 Clutch Control Idler Lever
12 Cotter Pin
13 Spacer

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Figure 5—Control Levers at Engine Compartment Bulkhead

Provisions are made for adjustment of control rod length by use of adjustable clevises. When replacing transmission or any of the control linkage, before attempting to operate vehicle, be sure linkage is adjusted as follows:

1. Remove 14 screws securing control access opening cover and 4 screws securing floor board at center step as shown in figure 3, and remove cover and floor board.

2. With clevises at end of shift rods (14) connected to idler levers (17), observe position of idler levers on bulkhead at rear of front axle and on engine compartment bulkhead. Center of clevis pins in clevises (16 and 18) must be in line with each other and 2.18 ± .03" from bulkhead. Center of clevis pin in bellcranks (22 and 23) must be centered on a line 1.5" from bulkhead. If necessary adjust adjustable clevis to bring about condition described. Tighten lock nuts (15) at clevises when adjustment is completed.

3. With transmission levers in neutral position adjust clevises on bellcrank-to-transmission rods (5 and 8, fig. 5) so clevis pins can be installed without moving gearshift control rods or transmission shift levers out of neutral position.

4. With engine running, shift transmission into each gear. If there is evidence of binding or other difficulty in shifting, recheck adjustments and inspect for damaged or worn components.

CONTROLS INSPECTION AND REPAIR

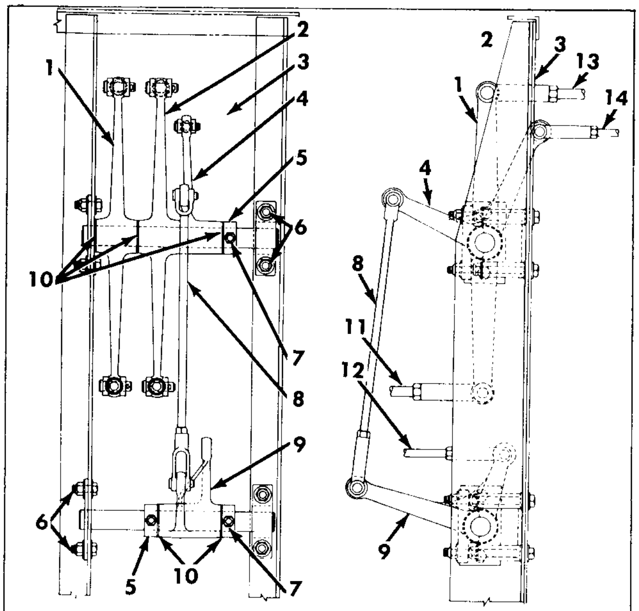
If adjustment procedures explained previously do not provide satisfactory operation, inspect control rod linkage and repair as described in the following text:

INSPECTION

1. Gain access to intermediate controls by removing intermediate control access cover (fig. 3).
2. Disconnect control rods from transmission levers in engine compartment (fig. 11).
3. Move gearshift lever through each speed position and check for evidence of binding or wear at adjustable clevises, lever assemblies, and control rod looms.
4. Disconnect control rods from shift rails of gearshift tower (fig. 4). Move gearshift lever through each speed position and check for damage in shift tower. If binding or damage is in shift tower, refer to "Transmission Gearshift Tower Replacement" in this section.

REPAIR

Control Rod Assemblies. Replace adjustable clevises which are damaged or worn at clevis pin holes. Control rods pass through looms which are sealed at each end with a bellows-type seal and seldom require maintenance. Replace damaged bellows-type seals which may allow dirt to enter looms. Control rods can be removed from looms



1 1st, 2nd, & Reverse Idler Lever
2 3rd & 4th Idler Lever
3 Front Axle Rear Bulkhead
4 Clutch Control Upper Idler Lever
5 Spacer (3 Req'd.)
6 Nuts with Bolts and Washers (8 Req'd.)
7 Spacer Set Screw
8 Vertical Control Rod (Clutch)
9 Clutch Control Lower Idler Lever
10 Thrust Washers (6 Req'd.)
11 Front Control Rod (2 Req'd.)
12 Clutch Front Control Rod
13 Intermediate Shift Rod (2 Req'd.)
14 Clutch Intermediate Control Rod

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Figure 6—Intermediate Idler Lever Installation

for cleaning and straightening by removing adjustable clevises and sliding rod out of loom.

NOTE: Rear control rods may be removed through engine compartment only after removal of engine from coach.

Clean control rods thoroughly with kerosene or fuel oil before reinstalling in looms.

Lever Assemblies. Bellcrank type levers located on front axle rear bulkhead (fig. 6) and engine compartment bulkhead (fig. 5), use nylon lined shaft bearings which do not require periodic lubrication. If levers or bearings are damaged or worn replace as follows:

INTERMEDIATE IDLER LEVERS (Fig. 6)

1. Disconnect intermediate control rods (13 and 14) from idler levers.
2. Disconnect vertical rod (8) from clutch control upper lever (4).
3. Disconnect front control rods (11 and 12) from idler levers.
4. Remove bolts with nuts and washers (6) which secure shaft assembly to bulkhead.

NOTE: Remove only top or bottom shaft assembly, whichever requires repair.

5. Loosen set screw (7) securing spacer (5) to shaft. Slide shaft out of bulkhead brackets, removing spacer, idler levers, and thrust washers (10) as shaft is withdrawn.
6. Replace worn or damaged shaft bearings and clevis pin bushings in idler levers.

NOTE: Lubricate nylon lined shaft bearings in idler levers with zinc oxide and calcium type grease before reassembling levers on shaft.

7. Slide shaft through bracket on bulkhead and position idler levers, spacers (5), and thrust washers (10) as shaft is inserted.
8. Secure shaft in position on bulkhead with bolts, washers and nuts (6).
9. Secure spacer (5) in position on shaft by tightening set screw (7).
10. Connect control rods to idler levers and refer to "Control Rod Adjustment" in this section.

REAR IDLER LEVERS (Key numbers in Fig. 5)

1. Remove clevis pins (7) securing all control rods to idler levers (9, 10, and 11). Remove cotter pin (12) from upper end of shaft.
2. Remove two bolts attaching shaft and lower bracket assembly (6) to bulkhead bracket.
3. Loosen five bolts attaching shaft upper bracket (1) to bulkhead.
4. Swing lower end of shaft and lever assembly out and remove shaft from upper bracket.
5. Remove spacer (13), idler levers (9, 10, and 11), and thrust washers (8) from shaft.
6. Replace nylon lined bearings and clevis pin bushings in idler levers if worn or damaged.

NOTE: Lubricate nylon lined bearings in idler levers with zinc oxide and calcium type grease before reassembling levers on shaft.

7. Assemble parts on shaft and lower bracket assembly (6) in the following order, referring to figure 5 for position of idler levers; two thrust washers (8); idler lever (9); two thrust washers (8); idler lever (10); two thrust washers (8); idler lever (11); and spacer (13).
8. Insert upper end of shaft through upper bracket (1) and position lower bracket at bulkhead bracket. Attach lower bracket to bulkhead bracket with two bolts, washers, and nuts. Tighten nuts to 20-25 foot-pounds torque. Tighten upper bracket to bulkhead bolts. (Nut torque is 20-25 ft.-lbs.; bolt torque is 35-40 ft.-lbs.)
9. Check clearance between upper end of spacer (3) and lower side of upper bracket (1). Install spacing washer (8) at this point if necessary to maintain 0.010" to 0.020" working clearance.
10. Connect control rods to idler levers with clevis pins (7) and cotter pins.
11. Refer to "Control Rod Adjustment" in this section for adjustment instructions.

CONTROL LUBRICATION

The gearshift tower, bellcranks, and levers at transmission cover should be lubricated at intervals specified in LUBRICATION (SEC. 13).

TRANSMISSION GEARSHIFT TOWER REPLACEMENT

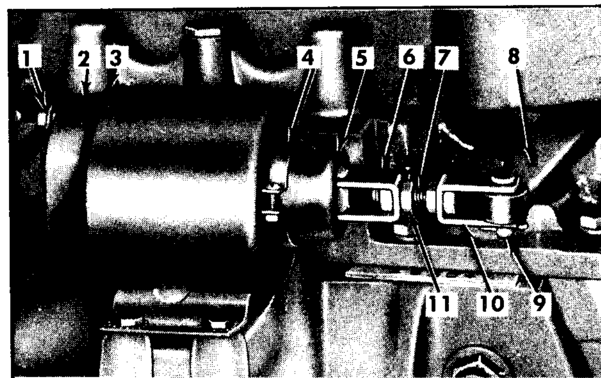
Gearshift tower mounted below floor at right of driver can be removed and disassembled as described below.

Removal

1. Through access hole in spare tire compartment, disconnect clutch pedal return spring from bracket below gearshift tower.
2. Remove pins which connect control rods to shift rails in bore of gearshift tower.
3. Remove nuts and washers securing gearshift tower to support bracket.
4. Inside coach, remove gearshift tower trim plate. Remove gearshift tower up through floor board.
5. If necessary to disassemble gearshift tower, the cap may be removed from top of tower to permit removal of lever. Four bolts at bottom of assembly may be removed to permit removal of shift rails and poppets.

Installation

1. Assemble gearshift tower components, referring to sectional view in figure 4 for construction. Mounting bolts are installed from upper side of tower and are threaded into base.
2. Install gearshift tower through floor board and position onto support bracket.
3. Secure gearshift tower to bracket with lock washers and nuts.
4. Connect transmission control rods to shift rail in gearshift tower with clevis pins. Secure clevis pins with new cotter pins.
5. Hook clutch pedal return spring to bracket.
6. Install and secure gearshift tower trim plate to floor board.



1 Terminal	7 Bolt
2 Cover	8 Reverse Lever
3 Felt Gasket	9 Clevis Pin
4 Clamp	10 Clevis
5 Dust Shield	11 Lock Nut
6 Link Assembly	

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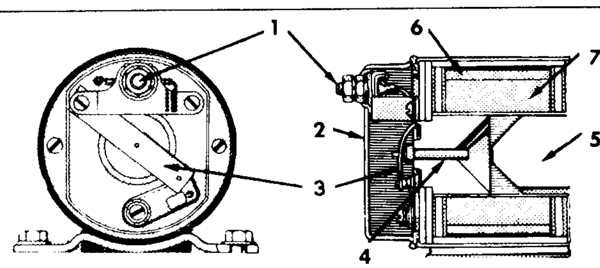
Figure 7—Reverse Solenoid and Linkage Installed

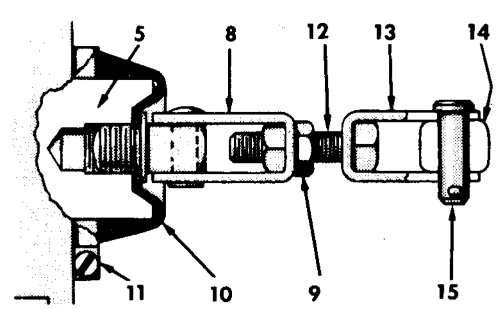
REVERSE SOLENOID AND LINKAGE ADJUSTMENT

Whenever the reverse solenoid has been removed or if difficulty is experienced when shifting transmission into reverse gear, the following procedure will properly adjust the solenoid linkage:

1. Be sure transmission control linkage is properly adjusted.
2. Place gearshift lever in 1st speed position.
3. Disconnect wire from terminal and remove



SECTIONAL VIEWS OF REVERSE SOLENOID



SOLENOID LINKAGE

1 Wire Terminal	6 Holding Coil	11 Clamp
2 Cover	7 Pulling Coil	12 Adjusting Bolt
3 Contact Points	8 Link Assembly	13 Clevis
4 Pin	9 Lock Nut	14 Lever
5 Plunger	10 Dust Shield	15 Clevis Pin

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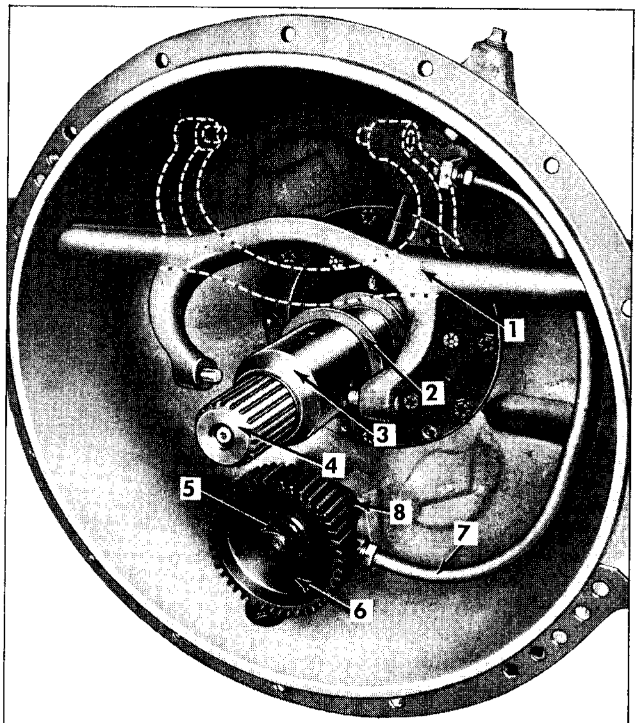
Figure 8—Sectional View of Reverse Solenoid and Linkage



1 Release Shaft and Yoke
2 Washer
3 Release Bearing Adapter
4 Drive Pinion Shaft
5 Snap Ring
6 Pump Driven Gear
7 Oil Pump Discharge Tube
8 Oil Pump Assembly

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Figure 9—Clutch Release Cross Shaft, Oil Pump Driven Gear, and Discharge Tube Installation

cover from solenoid. Inspect contact points. If points are burned or pitted, replace points or dress with a fine cut point file.

4. Operate lever (8, fig. 7) while observing contact points (3, fig. 8). As lever pushes plunger (5, fig. 8) inward, plunger must contact pin (4, fig. 8) and open points when plunger reaches end of stroke. When current is supplied to solenoid, both coils (6 and 7, fig. 8) are energized and cause magnetic pull on plunger; but when points open, the circuit through pulling coil (7, fig. 8) is broken and only the holding coil (6, fig. 8) remains energized. Damage to coils may occur if points do not open at end of plunger stroke.

5. If necessary to make an adjustment, refer to figure 7 and loosen lock nut (11), remove clevis pin (9) and turn clevis (10) while holding link assembly (6). Install clevis pin and tighten lock nut, then recheck action as directed in Step 4 above.

6. Start engine and check operation of the transmission controls.

LOW OIL PRESSURE SWITCH

To determine if low oil pressure switch (1, fig. 11) is functioning properly, turn on "ENGINE RUN" switch. With engine stopped, the "TRANS. OIL" tell-tale should be illuminated. When engine is running, the tell-tale should not be illuminated.

If the tell-tale does not illuminate with engine stopped, connect a jumper wire between the switch terminal and ground. If tell-tale does not light with jumper in place, the wiring or tell-tale bulb is defective. Refer to ELECTRICAL SYSTEM (SEC. 7) for required information and replace bulb or make necessary repairs.

If tell-tale does light with jumper wire connected across switch terminal, the switch is defective and must be replaced.

To determine if a switch is functioning properly, connect switch in series with battery and light bulb, and connect switch to a hydraulic pressure port equipped with a gauge and means for varying the pressure.

With no pressure applied, the bulb should light. As pressure rises the bulb should "go out" at 1-1/2 to 2-1/2 psi.

Replace switch in case of malfunction.

LUBRICATION SYSTEM MAINTENANCE

Oil Filter Element Replacement

The oil filter assembly is mounted at base by three bolts threaded into oil filter adapter. The element is disposable type which threads onto a nipple on filter base.

At intervals specified in LUBRICATION (SEC. 13) replace filter element as follows:

1. Use a wrench on the "hex"-shaped lower end of element and turn the element cartridge counterclockwise and remove from base.

2. Wipe filter base with clean cloth and check base mounting bolts to see that they are tight.

3. Oil the mating rubber surface on new filter cartridge gasket, then screw cartridge onto base. Torque to specified limits. Do not overtighten.

4. Start engine and after running for several minutes check oil level on dipstick. Add oil as required to raise level to "OIL LEVEL" mark on transmission dip stick. Inspect filter for evidence of leakage.

TRANSMISSION OIL PUMP AND LINES

CHECKING PUMP PRESSURE

Fluid pump is gear type, mounted inside clutch housing, and is driven by gear on clutch release sleeve.

To check pump pressure, remove pressure switch (fig. 2) and connect pressure gauge. Start engine and operate at free engine governed speed. Note gauge reading which should be 20 to 60 psi if oil is warm.

If test indicates that pump is not functioning properly, remove and overhaul or replace pump assembly.

PUMP REMOVAL

Key numbers in text refer to figure 9.

Pump is accessible only when transmission and clutch housing assembly are removed (fig. 8).

1. Disconnect discharge tube (7) from pump (8).
2. Remove snap ring (5), then pull pump fiber driven gear (6) from pump drive shaft.
3. Remove four cap screws attaching pump assembly (8) to clutch housing.
4. Remove pump assembly (8) and discard gasket. Remove inner snap ring from drive shaft (11, fig. 10).

PUMP DISASSEMBLY

Key numbers in text refer to figure 10.

1. Remove four machine screws which hold pump cover and body together. Tap with soft hammer to separate the cover (1) from body (6). Remove and discard 0.001" thick gasket (3) used between body and cover.
2. Remove driven gear (4) and shaft (9) assembly.
3. Remove drive gear (10) and shaft (11) from body.
4. If inspection indicates that bearings and gears require replacement, further disassembly is possible. Remove snap ring (7) from each end of idler and drive shaft. Press shafts from gears. If bearing assemblies (8) require replacement, they may be removed from cover (1) and body (6) and new bearing assemblies can be pressed into place.

CLEANING AND INSPECTION

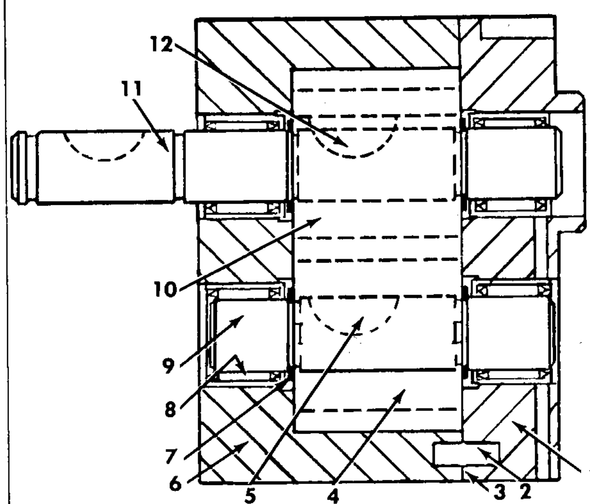
1. Clean all pump components thoroughly, using cleaning solvent. Be sure that bearings are clean.
2. Inspect shafts at areas contacted by bearing for evidence of wear.
3. Inspect pump gears for wear, nicks, or other damage that would render these parts unfit for further service.
4. Inspect pump body and cover for evidence of wear at points contacted by gears.

PUMP ASSEMBLY

Key numbers in text refer to figure 10.

During assembly operation apply transmission oil freely to all parts to prevent rusting and provide initial lubrication.

1. Press bearing assemblies (8) into place in body and cover.
2. Install one snap ring (7) and gear key (12) in drive shaft (11), install drive gear (10), and retain with other snap ring (7).



1 Body Cover	7 Gear Snap Ring
2 Dowel Pin	8 Shaft Bearing
3 Gasket	9 Driven Shaft
4 Driven Gear	10 Drive Gear
5 Gear Key	11 Drive Shaft
6 Body	12 Gear Key

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Figure 10—Sectional View of Oil Pump

3. Install one snap ring (7) and gear key (5) in driven shaft (9), install driven gear (4), and retain with other snap ring (7).
4. Set drive and driven gears and shaft assemblies in place in body.
5. Place new 0.001" thick gasket on body, install cover assembly on body, and install four machine screws. Tighten screws alternately and firmly to seat cover firmly at body.

PUMP INSTALLATION (Fig. 9)

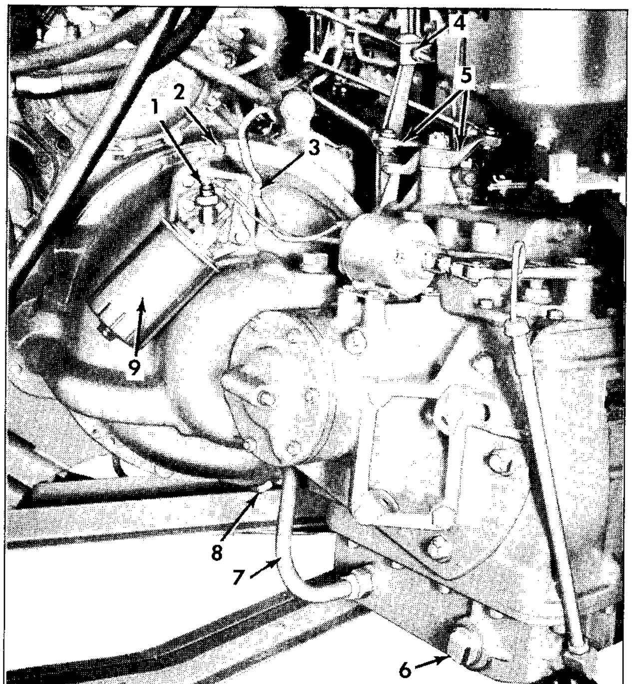
1. Install gasket to clutch housing.
2. Position pump assembly to clutch housing.
3. Secure pump with four cap screws, being careful that screws are tightened evenly and alternately so as not to cause pump to bind.
4. Connect discharge tube to pump.
5. Install inner snap ring on drive shaft, then install Woodruff key and fibre driven gear. Install outer snap ring.
6. Rotate pump driven gear to be sure pump is operating freely and does not bind.

TRANSMISSION REPLACEMENT

REMOVAL

Key numbers in text refer to figure 11 unless otherwise indicated.

1. Open engine compartment doors. Remove dust pans - one below transmission, and one below propeller shaft.



1 Oil Pressure Switch	5 Transmission Shift Lever
2 Bolt and Washer - Mounting	6 Transmission Drain
3 Clip - Harness	7 Suction Tube
4 Clutch Control Linkage	8 Clutch Housing Drain
	9 Transmission Oil Filter

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Figure 11—Transmission Installed

2. Disconnect propeller shaft at transmission, referring to PROPELLER SHAFT (SEC. 18) for necessary information. Also disconnect wire from speedometer sending unit.

3. Disconnect wires from terminals (1, fig. 7) on reverse solenoid and oil pressure switch (1). Remove bolts securing harness clip (3) to transmission.

4. Disconnect transmission shift rods from levers (5) at transmission cover. Disconnect clutch rod from clutch control lever.

5. Remove oil drain plugs (6 and 8). Drain oil from clutch housing and oil reservoir.

6. Loosen clamp bolt nut at clutch control lever, then remove lever from clutch release cross shaft.

SAFETY CAUTION

Before proceeding with next step, block coach body securely. When attaching hoist to take weight of transmission, the coach body may be inadvertantly raised just enough to cause height control valve to exhaust, in which case entire weight of rear end of coach will be placed on hoist.

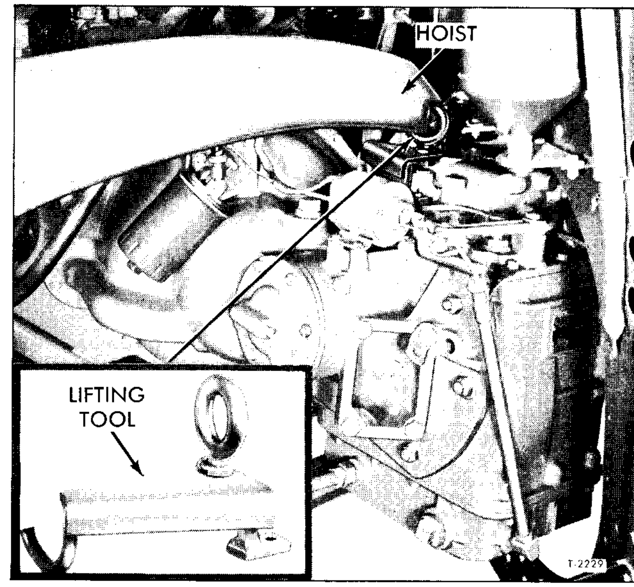


Figure 12—Removing Transmission with Hoist and Lifting Tool

7. Attach hoist to transmission using suitable lifting tool (fig. 12). Remove four bolts with tubular spacers attaching transmission to flywheel housing (from flywheel housing side). Remove remaining bolts (2) and washers attaching transmission to flywheel housing. Lifting the transmission, move straight away from engine until splines are disengaged. As transmission is being moved away from engine, rotate clutch release cross shaft to disengage release yoke from thrust ring. Turn transmission and remove from engine compartment.

8. Remove and discard gasket between clutch housing and flywheel housing.

INSTALLING TRANSMISSION

NOTE: Before installing transmission, condition of clutch parts should be carefully checked. Refer to CLUTCH (SEC. 5) for instructions in regard to inspection of clutch parts and setting of release levers.

1. Place new gasket at clutch housing flange. Use light coat of cement to hold gasket in place.

NOTE: To assist in installation, diaphragm spring should be so positioned that long finger which engages slot in oil pump drive gear is on right side of engine or toward bulkhead (3 o'clock). In this position pump drive gear can be tilted as illustrated in figure 13. Coat oil pump drive gear bushing with light weight grease.

2. Turn clutch release thrust ring so that thrust ring pin is down as shown in figure 14. Clutch release cross shaft yoke must be up as shown in dotted lines in figure 9.

3. Lift transmission with beam hoist and lifting tool. Move transmission into engine compartment and guide splined pinion shaft and release

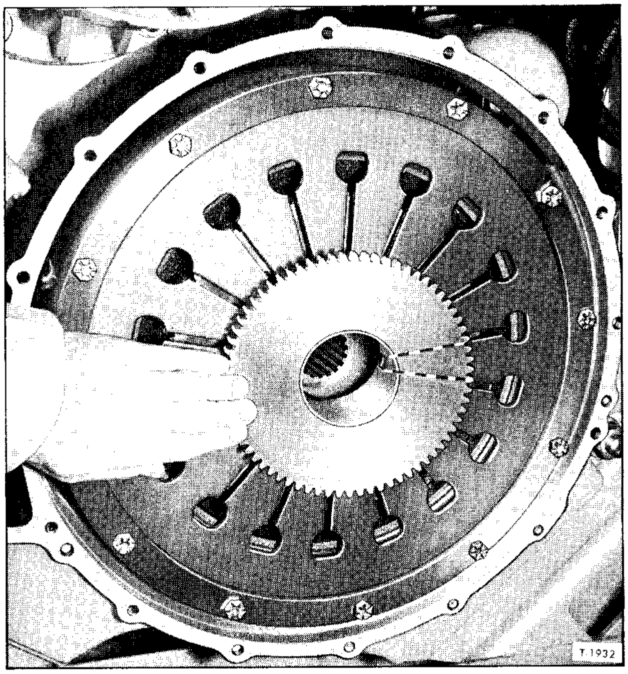


Figure 13—Clutch Diaphragm Spring Position

bearing adapter into oil pump drive gear.

4. With transmission in gear, rotate propeller shaft yoke to align pinion shaft splines and drive flange splines as transmission is moved toward engine flywheel housing.

NOTE: During above procedure turn clutch release shaft so that fork is between diaphragm spring and clutch release thrust ring as shown in figure 14.

5. When clutch housing is within approximately 1/2 inch of flywheel housing, feel oil pump driven gear through pipe plug opening in bottom of clutch housing. When a slight movement of gear is noted it indicates that oil drive and driven gears are meshing.

6. With clutch release cross shaft yoke properly positioned between diaphragm spring and release thrust ring (fig. 12), also with oil pump gears in mesh, transmission can now be moved into proper position against flywheel housing.

7. Align bolt holes in clutch housing with corresponding holes in flywheel housing. Install bolts and washers from flywheel housing side using four long bolts and tubular spacers at original locations. Install balance of bolts and washers from clutch housing side of bolting flange.

8. Remove lifting tool.

9. Connect propeller shaft at yoke on transmis-

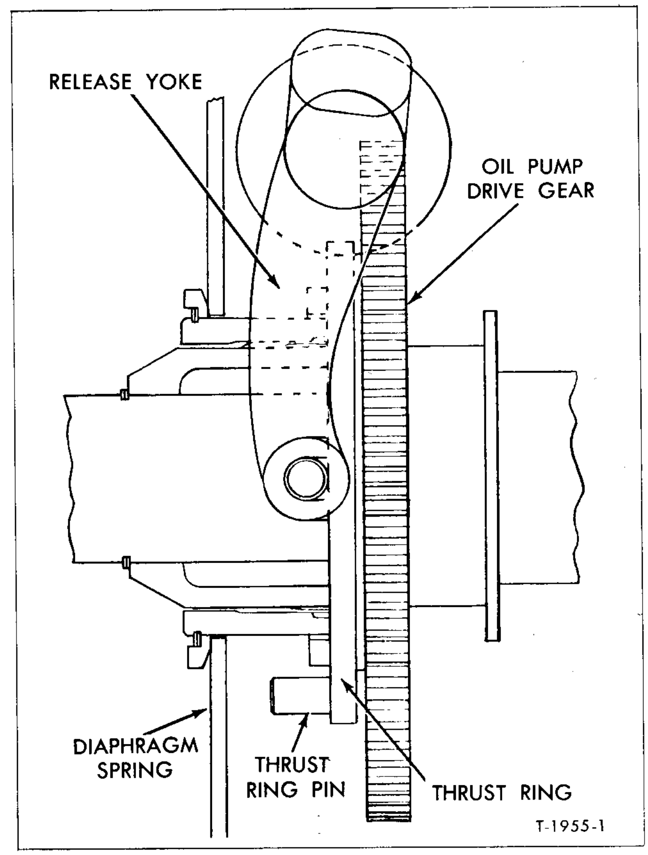


Figure 14—Operating Position of Clutch Release Shaft Yoke and Thrust Ring Pin

sion output shaft. Refer to PROPELLER SHAFT (SEC. 18) for installation.

10. Install clutch control lever on release cross shaft and secure with clamp bolt and nut.

11. Connect shift rods to respective levers. Install clutch rod and adjust as directed in CLUTCH (SEC. 5). Check transmission control linkage and adjust, if necessary, referring to "Control Rod Adjustment" in this section.

12. Connect electrical wiring at oil pressure switch, reverse solenoid, and electric speedometer sending unit. Check the operation of reverse solenoid and adjust solenoid linkage if required, referring to "Reverse Solenoid and Linkage Adjustment" previously covered in this section.

13. Check drain plugs, which must be tight, in clutch housing and oil reservoir.

14. Install dust pans, one below transmission and one below propeller shaft.

15. Fill transmission to "OIL LEVEL" mark on dipstick. Refer to LUBRICATION (SEC. 13) for correct type and quantity of lubricating oil.

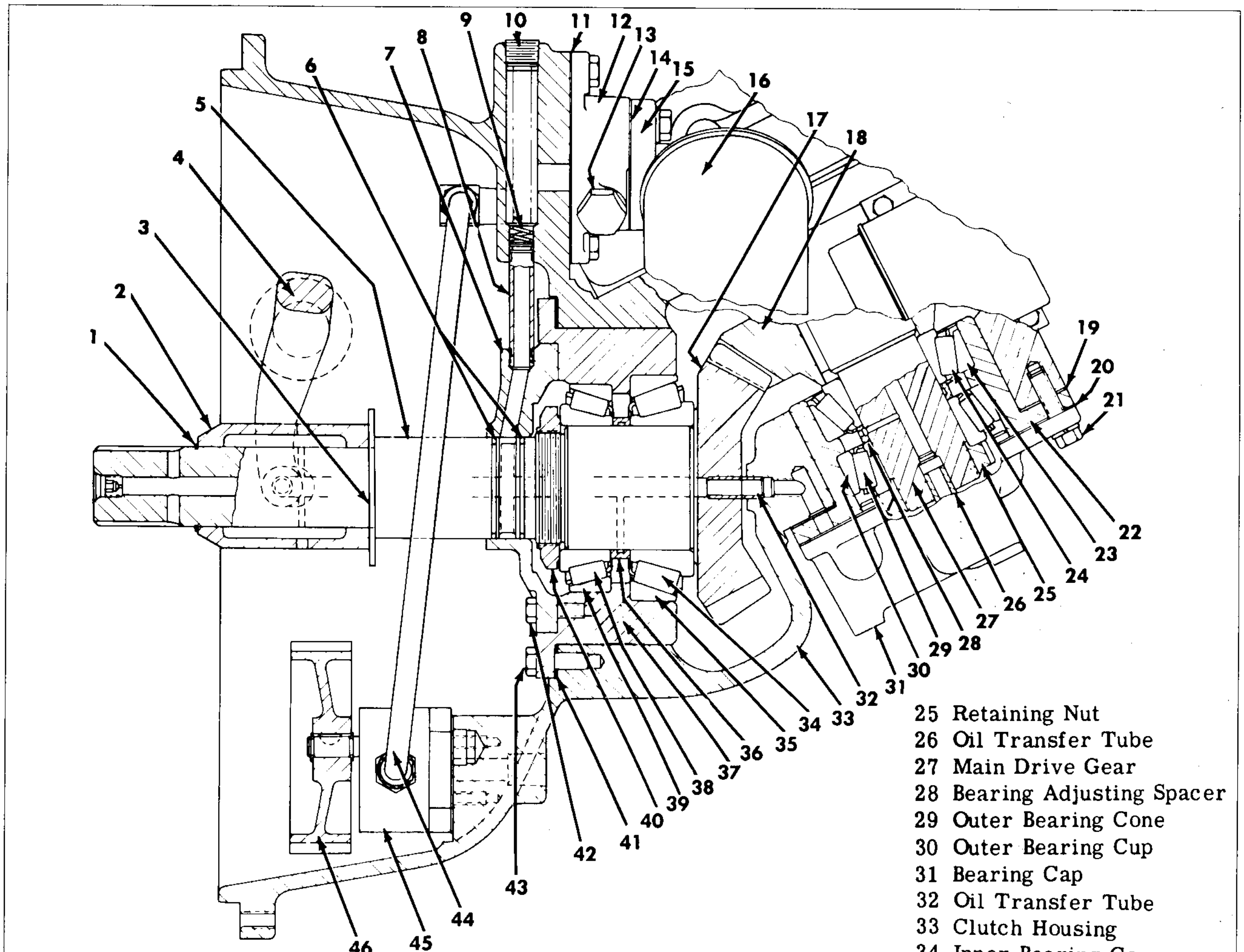
TRANSMISSION OVERHAUL

DISASSEMBLY INTO MAJOR COMPONENTS

REMOVING REVERSE SOLENOID AND TRANSMISSION COVER

Key numbers in text refer to figure 1.

1. Remove bolts which attach reverse solenoid (4) and lever (6). Remove speedometer sending unit.
2. Remove bolts which attach cover assembly (6) to transmission case, then remove the cover assembly including shift levers and forks.
3. Remove cover gasket.



1 Retaining Ring
2 Release Bearing Adapter
3 Washer
4 Release Cross Shaft
5 Drive Pinion Shaft
6 Seal Ring
7 Oil Transfer Flange
8 Oil Transfer Tube
9 Tube Retaining Spring
10 Plug
11 Gasket
12 Oil Filter Adapter
13 Pressure Regulator Valve
14 Gasket
15 Oil Filter Base
16 Oil Filter
17 Bevel Drive Pinion
18 Bevel Drive Gear
19 Adjusting Shims
20 Gasket
21 Cap Screw
22 Bearing Retainer
23 Inner Bearing Cup
24 Inner Bearing Cone
25 Retaining Nut
26 Oil Transfer Tube
27 Main Drive Gear
28 Bearing Adjusting Spacer
29 Outer Bearing Cone
30 Outer Bearing Cup
31 Bearing Cap
32 Oil Transfer Tube
33 Clutch Housing
34 Inner Bearing Cone
35 Inner Bearing Cup
36 Bearing Adjusting Spacer
37 Bearing Retainer
38 Outer Bearing Cone
39 Outer Bearing Cup
40 Retaining Nut
41 Adjusting Shims
42 Cap Screw
43 Cap Screw
44 Oil Tube
45 Oil Pump Assembly
46 Pump Driven Gear

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Figure 15—Cross Section at Transmission Bevel Gears

REMOVING CLUTCH HOUSING
AND BEVEL DRIVE GEARS

Key numbers in text refer to figure 15 unless otherwise indicated.

1. Remove oil filter and base assembly from adapter on clutch housing.

2. Remove stud nuts and washers attaching bearing cap (31). Remove bearing cap assembly and gasket (20).

3. Referring to figure 17 shift the sliding clutches to lock mainshaft so it cannot be turned, then remove bearing retaining nut (25) from drive gear (27).

4. Using puller screws in tapped holes in flange on bearing retainer (22) pull retainer and bearing assembly (29) out of clutch housing (33). Remove and tag shims (19) so same shims can be installed at assembly.

5. Remove stud nuts and washers which hold clutch housing in place on transmission case (two of the nuts are at transmission case flange), then with lead hammer, jar clutch housing loose and remove from studs.

6. Remove bearing spacer (28) and any shims which may be present. Tie spacer and shims (if used) together for use at assembly. Remove inner bearing assembly (24).

7. Remove bevel drive gear (89, fig. 17) from drive gear (15, fig. 17), pry key (8, fig. 17) out of slot in shaft, and remove spacer (9, fig. 17).

REMOVING OIL RESERVOIR

1. Remove stud nuts and washers which attach oil reservoir to transmission case. Remove reservoir and gasket.

2. Remove screws which hold screen to reservoir and remove screen.

REMOVING REVERSE IDLER GEAR

1. Remove reverse idler gear shaft cover plate at rear of transmission case.

2. Use puller in tapped hole in reverse idler gear shaft and pull shaft out of transmission case. Referring to figure 16 remove reverse gears, thrust washers and bearings.

REMOVING MAINSHAFT ASSEMBLY
AND DRIVE GEAR

Key numbers in text refer to figure 17.

1. With sliding clutches shifted to lock transmission and prevent shafts from turning, remove nut (42) and washer (41) which retain yoke assembly (43) on mainshaft (39). Remove yoke assembly from mainshaft splines.

2. Remove stud nuts and washers which retain rear bearing cap (36), then remove bearing cap (36) and shims (35). Remove and tag shims (35) for reference at reassembly.

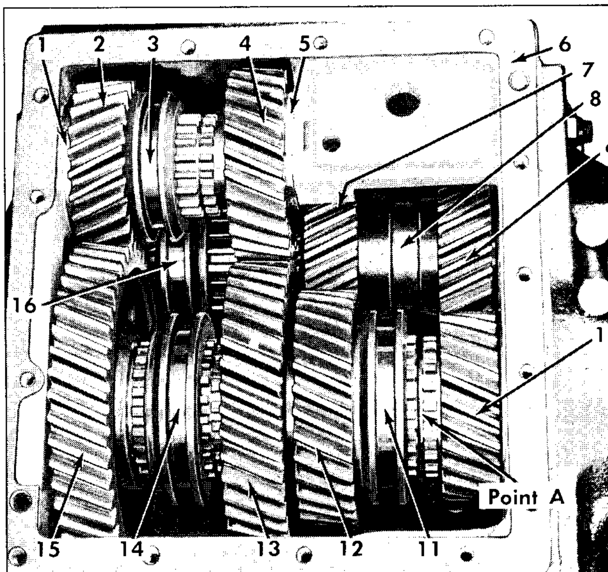
3. Remove stud nuts and lock washers securing countershaft rear cap (52). Remove cap (52) and gasket. Remove brake plates (51), facing plate (48), springs (47), pins, and brake driver (49).

4. Remove cotter pin at countershaft nut, then loosen nut (83). Bend lock (53) away from nuts (50 and 58) at rear end of countershaft, remove nuts.

NOTE: The operations described in step 4 are not required in order to remove mainshaft and gears, but should be performed while both shafts are locked to facilitate loosening the countershaft nuts if countershaft is to be disassembled.

CAUTION: To avoid damage to countershaft rear bearing when removing nuts (50 and 58), use a short socket or partially fill cavity in deep socket with suitable spacer to prevent socket from contacting bearing cage.

5. At front of transmission remove bolts which attach bearing retainer (10), then use two 3/8-16 bolts in puller screw holes in retainer flange to pull retainer (10), bearing (12) and drive gear (15) out of transmission case. Remove mainshaft pilot bearing (14) from mainshaft.



1 Rear Thrust Washer	10 Drive Gear
2 Reverse Idler Driven Gear	11 3rd and 4th Speed Sliding Clutch
3 Reverse Idler Sliding Clutch	12 Mainshaft 3rd Speed Gear
4 Reverse Idler Drive Gear	13 Mainshaft 2nd Speed Gear
5 Front Thrust Washer	14 1st and 2nd Speed Sliding Gear
6 Cover Gasket	15 Mainshaft 1st Speed Gear
7 Countershaft 3rd Speed Gear	16 Countershaft Sliding Clutch
8 Gear Spacer	
9 Countershaft Drive Gear	

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Figure 16—Transmission with Cover Removed

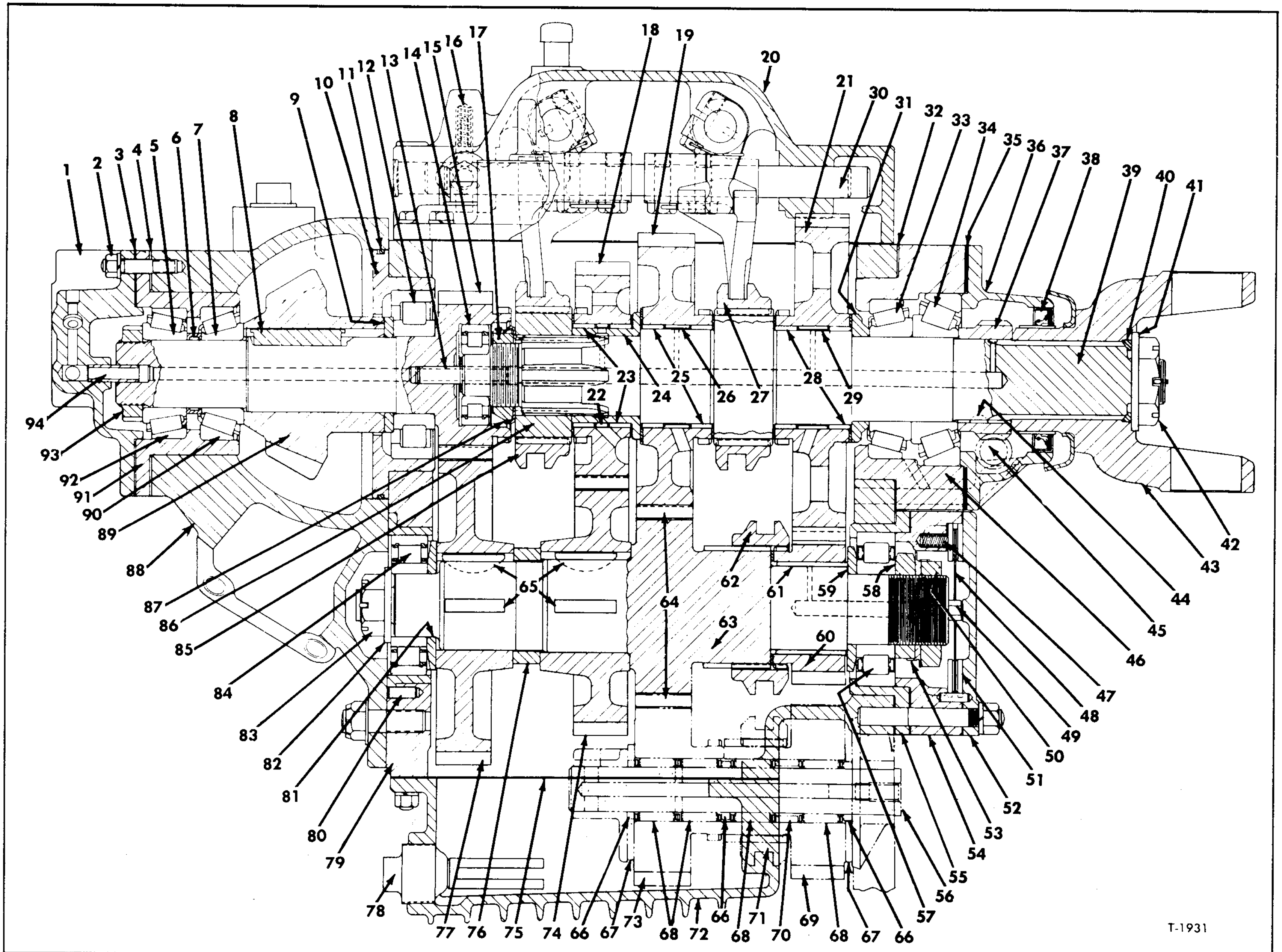


Figure 17—Sectional View of Transmission

1	Bearing Cap Assembly	25	2nd Gear Bearings	49	Brake Driver	72	Oil Reservoir
2	Stud and Nut	26	Bearing Spacer	50	Outer Nut	73	Reverse Idler Gear
3	Gasket	27	Sliding Clutch	51	Brake Plate	74	3rd Speed Gear
4	Shims	28	1st Gear Bearings	52	Brake Cover	75	Oil Screen
5	Outer Bearing	29	Bearing Spacer	53	Nut Lock	76	Gear Spacer
6	Adjusting Spacer	30	Shifter Shafts	54	Brake Retainer	77	Countershaft Drive Gear
7	Inner Bearing	31	Thrust Washer	55	Bearing Retainer	78	Drain Plug
8	Key	32	Gasket	56	Reverse Idler Shaft	79	Transmission Case
9	Spacer	33	Inner Bearing	57	Countershaft Bearing	80	Dowel Pin
10	Bearing Retainer	34	Outer Bearing	58	Lock Nut	81	Gear Washer
11	Retainer Seal	35	Shims	59	Thrust Washer	82	Bearing Washer
12	Drive Gear Bearing	36	Retainer	60	1st Speed Gear	83	Countershaft Nut
13	Oil Tube	37	Speedometer Gear	61	Bushing	84	Countershaft Bearing
14	Pilot Bearing	38	Oil Seal	62	Sliding Clutch	85	3rd and 4th Sliding Clutch
15	Main Drive Gear	39	Mainshaft	63	Countershaft	86	Mainshaft Clutch Gear
16	Shifter Poppet	40	Seal	64	2nd Speed Gear Teeth	87	Nut Lock
17	Mainshaft Nut	41	Washer	65	Gear Keys	88	Clutch Housing
18	3rd Speed Gear	42	Nut	66	Bearing Spacer	89	Bevel Gear
19	2nd Speed Gear	43	Yoke	67	Thrust Washer	90	Inner Bearing Cup
20	Transmission Cover	44	Key	68	Bearing Assembly	91	Bearing Retainer
21	1st Speed Gear	45	Driven Gear	69	Reverse Driven Gear	92	Outer Bearing Cup
22	Bearing Spacer	46	Bearing Retainer	70	Bearing Spacer	93	Retaining Nut
23	3rd Gear Bearings	47	Brake Spring	71	Reverse Sliding Clutch	94	Oil Tube
24	Thrust Collar	48	Brake Disc				

Captions For Figure 17

6. Remove speedometer drive gear (37), then remove key (44) from mainshaft.

7. Use two 7/16-14 bolts in puller screw holes in flange on bearing retainer (46), to pull retainer and bearing (33, and 34) out of case. Remove retainer and bearing assembly from rear end of mainshaft, then tie mainshaft gears to hold them in place and lift the mainshaft and gear assembly out of transmission case.

REMOVING COUNTERSHAFT ASSEMBLY

1. With nuts (50 and 58) removed from rear end of countershaft (see step 4 in preceding operation) assemble puller to rear bearing retainer (55). Use two 7/16-14 bolts to attach puller to retainer. Tighten puller screw against rear end of countershaft to pull retainer out of case (79) and at the same time remove rear bearing (57) from countershaft.

2. Use arbor press to remove bearing (57) from retainer (55).

3. Remove countershaft 1st speed gear (60) and thrust washer (59) from rear end of countershaft, move countershaft assembly rearward, then raise front end of countershaft and remove the assembly from the transmission case.

DISASSEMBLY OF SUBASSEMBLIES

(Key numbers in text refer to figure 17)

MAINSHAFT DISASSEMBLY

1. Untie gears and remove first speed gear (21) bearings (28) and spacers (29), first and second speed sliding clutch (27) and third and fourth speed clutch (85).

2. Raise tangs on lock (87) and remove nut (17) from end of mainshaft (39).

3. Remove clutch gear (86), then remove 3rd speed gear (18), bearings (23) and spacer (22). Remove thrust collar (24) from mainshaft, then remove 2nd speed gear (19), bearings (25) and spacer (26).

COUNTERSHAFT DISASSEMBLY

1. Remove low speed gear sliding clutch (62).

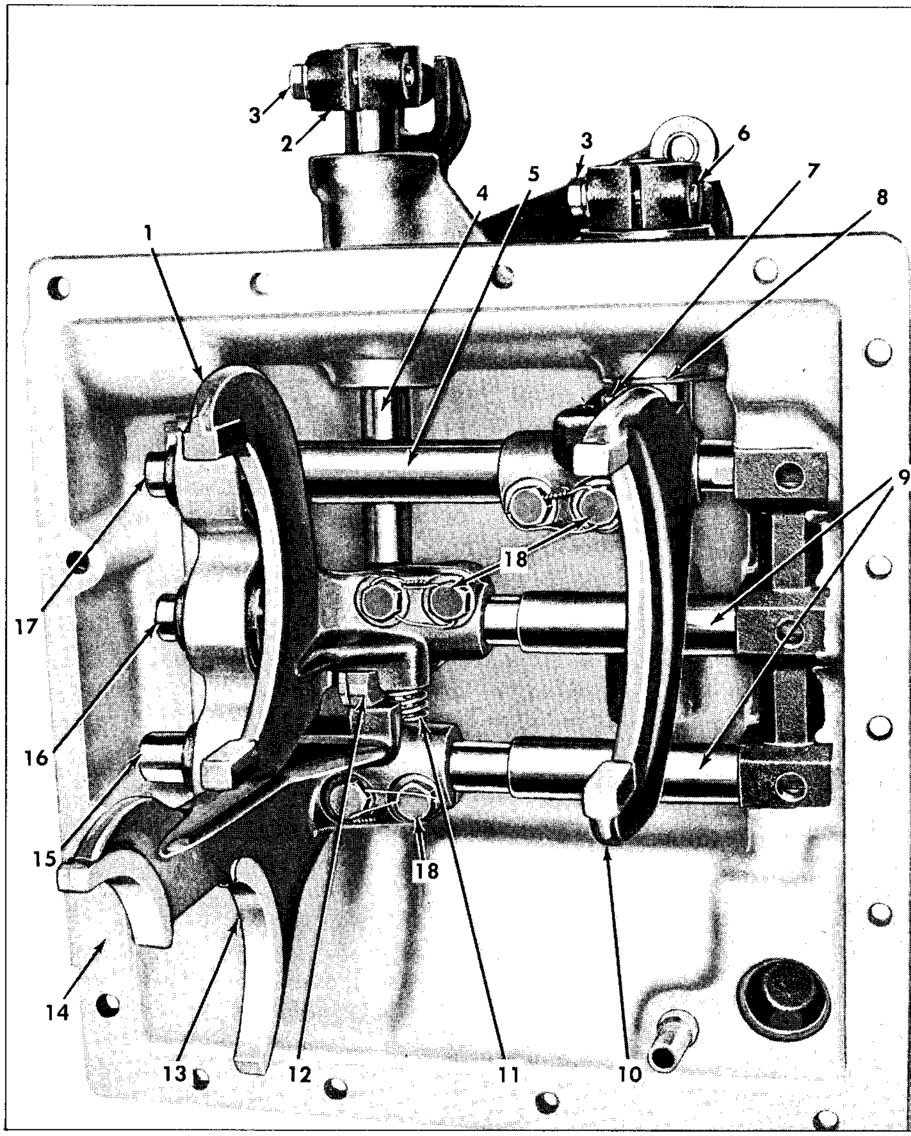
2. With front bearing nut (83) and washer (82) removed, remove front bearing (84), and retaining washer (81).

4. Drive gear (77), and gear (74) may be pressed off countershaft separately. Keys (65) at front of countershaft must be removed before spacer (76) and gear (74) can be removed.

BEVEL GEAR AND BEARING DISASSEMBLY

Key numbers in text refer to figure 15 unless otherwise indicated.

1. Remove plug (10) and spring (9) from oil transfer passage in clutch housing, then lift oil



1 1st and 2nd Shift Fork
2 Shaft Outer Finger
3 Clamp Bolt
4 1st, 2nd and Reverse Shift Finger Shaft
5 Shift Rod Stop Sleeve
6 Outer Finger
7 Inner Finger
8 Shaft Washer
9 Shift Rod Stop Sleeves
10 3rd and 4th Shift Fork
11 Shift Shaft Spring
12 1st, 2nd and Reverse Inner Finger
13 Reverse Shift Fork
14 Cover
15 Reverse Shift Rod
16 1st and 2nd Shift Rod
17 3rd and 4th Shift Rod
18 Fork Bolts

Figure 18—Transmission Cover, Forks, and Shifting Mechanism

transfer tube (8) from oil transfer flange (7).

2. Remove five cap screws attaching oil transfer flange (7) to bearing retainer (37). Install puller screws in tapped holes of flange (7) and remove flange (7).

3. Remove bearing retainer bolts (43), then using puller screws in tapped holes in retainer flange, force the bearing retainer (37), out of clutch housing. Drive pinion (5) and bearings (34 and 38). will come out with the retainer. Remove two seals (6) from drive pinion. Tag shims (41) so original pack may be used when reassembling.

4. Drive flat wedge under front edge of nut to raise staked portion of nut (40) out of slots in drive pinion (5), then remove bearing retaining nut. Use arbor press and press on front end of drive pinion (5) to remove pinion and inner bearing assembly (34) from retainer (37). Remove outer bearing assembly (38) from retainer and remove bearing spacer (36) and shims together for use when assembling. Use suitable drift through holes in pinion gear to drive inner bearing assembly (34) off pinion shaft, when it is necessary to replace inner bearing assembly. Bearing cups (35 and 39) can be removed from retainer (37) if worn or damaged.

TRANSMISSION COVER AND SHIFT MECHANISM DISASSEMBLY

Key numbers in text refer to figure 18 unless otherwise indicated.

1. Remove levers from transmission cover. Outer fingers (3 and 8) are held to respective

shafts by clamp bolt and lock washer and are located by Woodruff keys.

2. Move all shift forks to neutral position and remove lock wires used to secure bolts (18).

3. Remove clamp bolts which hold 3rd and 4th shift fork (10) on rod (17). Drive rod (17) forward through fork and force hole plug out of cover. Remove rod (17) sleeve (5) and fork (10). Hold hand over hole in cover boss below poppet and catch poppet ball, plunger and spring as rod is removed from cover.

4. Remove two clamp bolts holding fork (1) on shift rod (16), then drive rod (16) forward out through cover in same manner as described in step 3 above. Use care not to lose poppet parts.

5. Remove two clamp bolts holding reverse shift fork (13) to shift rod (15). Drive rod (15) forward and remove in same manner as previously described for removing rods (16 and 17). Remove threaded plug from side of cover, then remove two shift rod interlocks.

6. At outer side of cover, remove reverse lever collar from shift finger shaft (4). Remove clamp bolt from 1st, 2nd, and reverse inner finger (12), move finger to expose Woodruff key, and remove key. Pull shaft (4) out of cover and remove washer, spring (11) and inner finger (12) from inside cover.

7. Remove clamp bolt from inner finger (7), move finger to expose Woodruff key and remove key. Remove shift finger shaft from cover, and remove inner finger (7) and washer (8) from inside cover. If finger shaft oil seals require replacement, drive old seals out of transmission cover.

CLEANING AND INSPECTION

Clean all parts carefully in suitable cleaning fluid and blow dry with compressed air.

All bearings should be cleaned thoroughly. After bearing assemblies have been soaked in cleaning fluid, tap them sharply on a block of wood to dislodge any solid particles. Slush them again in cleaning fluid and blow dry with air. Do not spin the bearings with the air - revolve them slowly in races with fingers as air is directed at right angles to the balls or rollers. Examine races and bearings for pits and scores, then oil each assembly thoroughly with clean engine oil.

Individual needle bearing rollers which were removed from main shaft gears should be thoroughly washed and inspected. Replace those bearing rollers which show signs of scores or pits. (There are 138 rollers to each gear.)

Examine teeth on all gears carefully for nicks and worn spots. Do not take chances with gears which are appreciably nicked or scored. Small nicks may be carefully removed with a "slip-stone" or hone.

Clean interior of main case and covers thoroughly. Remove magnetic drain plug and clean all particles of metal from magnet and remove all dirt from screen. Blow out all oil passages with compressed air.

Inspect faces on shift forks which contact respective sliding clutches. If forks or sliding clutches are worn or scored replace parts as necessary.

ASSEMBLY OF SUBASSEMBLIES

Key numbers in text refer to figure 17 except as otherwise indicated.

COUNTERSHAFT ASSEMBLY (Fig. 15)

1. Press third speed countershaft gear (74) onto shaft with long hub of gear toward front. Make certain that both keys (65) are in position and keyways are free from burrs.

2. Place spacer (76) and keys (65) in position and press drive gear (77) onto shaft with long hub of gear toward rear.

3. Install drive gear retaining washer (81) with recessed edge toward bearing (84).

4. Install front bearing (84), retaining washer (82) and nut (83). Tighten nut finger tight.

5. Install sliding clutch (62) over countershaft clutch gear with long hub toward front. Do not install first speed gear (60) at this time.

MAINSHAFT AND DRIVE GEAR ASSEMBLY (Fig. 17)

1. Place mainshaft (39) in vise with rear end of shaft down (vise should be equipped with "soft" jaws).

2. Make sure second speed gear (19) is clean, especially on inside diameter, then apply a coat of heavy gear oil. Place gear over mainshaft with gear clutch teeth toward rear.

3. Install 69 roller bearings (25) in hub of gear. Install bearing spacer (26) and push bearings and spacer in position. Then install another row of roller bearings.

4. Install third speed gear thrust collar (24) with oil hole indexed with oil hole in shaft. Install third speed gear (18), bearings (23) and spacer (22) in same manner as second speed gear, except that gear clutch teeth are toward front.

5. Install third and fourth speed clutch gear (86) over splines of mainshaft with chamfered end of splines toward rear. Install sliding clutch (85) over gear (86) with extended edge of gear toward rear.

6. Install lock (87) and retaining nut (17) and tighten nut firmly. Bend lock over flat of nut (17). Install pilot bearing (14) on mainshaft pilot.

7. Position mainshaft with rear end upward, then install sliding clutch (27) with extended edge toward rear (upper) end of mainshaft. Place 1st

speed gear (21) on mainshaft with clutch teeth toward sliding clutch (27). Install 1st speed gear bearings (28) and bearing spacer (29) in same manner as described previously for installing second and third speed gears (18 and 19).

8. Coat inner face of thrust washer (31) with grease and place in position. Grease will prevent washer from sliding out of place when assembly is lowered into case and in that manner prevent bearings from falling out when shaft is tilted for installation. It is also a good practice to temporarily wire gears (18, 19, and 21) together to hold them in place while installing shaft.

NOTE: Assembly and adjustment of inner and outer tapered bearings (7 and 5) is accomplished during transmission build-up and is covered later in this section under "Assembly of Transmission."

DRIVE PINION AND BEARINGS ASSEMBLY

Key numbers in text refer to figure 15.

1. Press inner bearing assembly (34) into place on pinion (5).

2. Install cups (35 and 39) in bearing retainer (37) if cups have been removed.

3. If original retainer and bearings are being used, install bearing spacer (36) and shims which were removed at disassembly. If new bearings and/or retainer are being installed, select service spacer (36) (0.395" thick, #2419741) and service shims to provide a total thickness of 0.439 inches. Set pinion on bench with splines upward and lower the retainer (37) over pinion shaft (5) and into position at inner bearing (34). Position outer bearing (38) at pinion shaft and drive or press bearing into contact with spacer (36).

4. Install bearing retaining nut (40) and tighten to 500 foot-pounds torque; then measure endwise movement of pinion with respect to bearings. Make note of endwise movement and remove bearing nut, outer bearing assembly, spacer and shims.

5. Determine correct shim pack to use as follows:

Add 0.001 inch to the end play noted in step 4 above, then subtract this sum from the 0.439 inch dimension specified in step 3 above. The result is the correct total thickness for shims and spacer to provide proper bearing pre-load.

6. Select the combination of shims and spacer (36) to give total thickness specified above, and reassemble spacer, shims, outer bearing (39), and nut (40). Tighten nut to 500 foot-pounds.

7. Preload on pinion bearings should be 5 to 15 inch-pounds when bearing nut is tightened. Preload may be determined without a special torque measuring devise by using a spring scale on a string wrapped around the stem end of pinion. The force required on string to rotate pinion is from 5.5 to 17 pounds for proper pre-load.

If pull required to rotate pinion is not 5.5 to 17 pounds, the shim pack must be changed as necessary to provide correct pre-load. A change of 0.001 inch in shim pack will change the torque required to rotate pinion shaft by 7 inch-pounds.

8. When bearing adjustment is completed, stake the bearing retaining nut at slots in pinion to lock the nut.

ASSEMBLING TRANSMISSION COVER COMPONENTS

Key numbers in text refer to figure 18, unless otherwise specified.

1. Install 1st, 2nd, and reverse shift finger shaft (4) in cover, assembling flat washer, spring (11) and inner finger (12) as shaft is installed. Install finger key in shaft, then locate finger so clamp bolt will engage notch in shaft, and install clamp bolt in finger (12). Secure clamp bolt with lock wire. If shaft oil seals - one at each side of transmission cover - have been removed, drive new seals into place in cover with seal lips pointing inward. Install outer lever (2) on outer end of shaft (4) using Woodruff key and clamp bolt (3) with lock washer.

2. Install 3rd and 4th shift finger shaft in cover, assembling washer (8) and inner finger (7) on shaft as it is moved into place. Install Woodruff key in slot, locate inner finger (7) on shaft, and install clamp bolt. Secure clamp bolt with lock wire. Install shaft oil seal at outer side of cover if seal has been removed, then install outer finger (6) on outer end of shaft using key and clamp bolt (3) with lock washer.

3. Position cover assembly up-side-down, then drop 3rd and 4th shift rod poppet spring, plunger, and ball through hole in shift rod boss. Hold poppet ball down and insert 3rd and 4th shift rod (17) through hole in front of cover. When end of shift rod is through front support, hold shift fork (10) in cover and push shift rod through fork. Assemble stop sleeve (5) on rod, and move rod into position in cover. Notches in shift rod must be aligned with clamp bolt holes in fork (10) and inner finger (7) must engage notch in shift rod lug. Install two clamp bolts (18), tighten bolts firmly and secure with lock wire.

4. Place one interlock in hole between rods (16 and 17). Install spring, plunger, and poppet ball in center poppet hole, then install 1st and 2nd shift rod (16), stop sleeve (9), and shift fork (1) in position shown in figure 15. Inner finger (12) must engage notch in lug on fork (1). Install and tighten two fork clamp bolts (18) and secure with lock wire.

5. Place one interlock between rods (15 and 16) and move rods (16 and 17) to neutral position (poppet ball engaging center notch), then install spring, plunger, and poppet ball in poppet hole at reverse shift rod. Install reverse shift rod (15)

assembling stop sleeve (9) and shift fork (13) on rod as it is moved into place. Install and tighten two clamp bolts (18) and secure with lock wire.

6. Install three shift rod hole plugs at front of cover and install threaded hole plug at side of cover.

7. Referring to figure 1 install shift levers on transmission cover, with lever yokes engaging outer fingers as shown.

ASSEMBLY OF TRANSMISSION

Apply transmission oil on transmission parts to provide initial lubrication and prevent rusting.

TRANSMISSION MAIN CASE BUILD-UP

Key numbers in text refer to figure 17 unless otherwise indicated.

COUNTERSHAFT INSTALLATION

1. Place countershaft and gear assembly into case, tilt front end upward and lower rear end into case, inserting rear end through rear bearing hole in case far enough to permit front bearing (84) to be inserted into retainer.

2. Install first speed gear (60) on countershaft by inserting gear through rear bearing hole in case.

3. Install thrust washer (59), recessed edge toward outside of case.

4. Press rear bearing (57) into retainer (55). Place retainer gasket on studs at transmission case. Be sure retainer dowel pins are in place, then install bearing and retainer.

5. Install inner lock nut (58) and tighten to torque listed in "Specifications" at end of this section.

6. Install nut lock (53) and outer nut (50). Tighten nut and lock both nuts by bending lips of nut lock over flats of nuts.

NOTE: Steps 5, and 6 above may be deferred until after mainshaft has been installed, at which time the gears can be locked to prevent shafts from turning when tightening nuts.

REVERSE IDLER GEAR INSTALLATION

Refer to figure 17 and note position and width of spacers installed, at ends and in between roller bearings. Make sure that oil passages in shaft are clean and that plug in end of shaft is in place. Install reverse idler shaft in following manner:

1. Drive shaft into case just far enough to install thrust washer (66), driven gear (69), bearings (68) and spacers (57 and 61).

2. As shaft is driven into case, install remaining parts. Front thrust washer fits in notch in case as shown in figure 16.

3. After shaft is driven into case, flat on outer end of shaft must be in vertical position.

4. Install lock plate at rear of transmission case to hold reverse idler shaft in position.

MAINSHAFT AND MAIN DRIVE GEAR INSTALLATION

1. Tilt front end of mainshaft and gears assembly upward and lower rear end into transmission case and out through bearing retainer hole in case.

2. Fit drive gear (15) onto pilot bearing (14) on end of mainshaft assembly, then install retainer (10) and bearing (12) over end of drive gear and start retainer bolts into transmission case. Do not tighten retainer bolts until mainshaft rear bearing and retainer (46) have been installed.

3. Place retainer gasket (32) on studs in rear of case at mainshaft. Install rear bearing retainer (46) and inner bearing cone and cup assembly (33) over mainshaft and into transmission case.

4. Install outer bearing cone and cup assembly (34) on mainshaft and into bearing retainer (46).

5. Install bearing cap (36) over studs and against bearing retainer. Install nuts on four equally spaced studs, then tighten evenly and alternately until bearing cup (34) bottoms in retainer (46). DO NOT TIGHTEN NUTS EXCESSIVELY.

6. Using a feeler gauge measure gap between retainer (46) and cap (36) at three or four places to obtain an average.

7. Measure thickness of two gaskets being used between retainer (46) and cap (36). Add shims to the thickness of gaskets to fill gap previously obtained in step 6. Add an additional 0.005" shim to allow for crush on gaskets.

8. Remove nuts securing cap (36) and remove cap. Install key (44) in mainshaft, then install speedometer drive gear (37). Check to be sure oil holes in speedometer gear and mainshaft index with each other.

9. Install selected shims and gaskets (35) over studs with a gasket on each side of shim pack. Install cap (36) over studs. Install stud nuts, then pull mainshaft rearward to seat rear bearing cup against bearing retainer (46), then tighten stud nuts to torque listed in "Specifications" at end of this section.

10. Using a suitable dial indicator check mainshaft end play. Indicator should show reading of 0.002"-0.004", add or remove shims (35) as necessary to obtain required reading. Mainshaft must be rotated while checking end play.

11. Install yoke assembly (43) on mainshaft splines, install O-ring seal (40) in recess in yoke, then install washer (41) and nut (42).

12. At front of transmission case tighten drive gear bearing retainer bolts, then shift sliding clutches to lock transmission shafts. Tighten yoke nut (42) to torque listed in "Specifications" at end of this section. Install cotter pin to secure nut. If

countershaft bearing nuts have not been tightened, tighten inner nut (58), to torque listed in "Specifications" at end of this section, install nut lock (53). Install and tighten outer nut (50), then bend nut lock to prevent nuts from loosening. Also tighten countershaft nut (83) to torque listed in "Specifications" at end of this section.

CAUTION: There is danger of damaging countershaft rear bearing if too deep a socket is used in tightening nuts. If necessary install spacer in socket so edge of socket will not contact rear bearing (57).

13. If oil reservoir (72) is removed from transmission, attach screen (75) with three screws, then install reservoir on transmission case using a new gasket.

COUNTERSHAFT BRAKE INSTALLATION

1. Install countershaft brake retainer (54) over studs and against bearing retainer, using new gasket between retainers.
2. Install new cover gasket on brake retainer, then install three cover dowel pins, also three brake plate springs (47) into brake retainer.
3. Install inner brake plate, brake disc (48), and outer brake plate (51), in brake retainer (54). Install hexagon brake driver (49) through brake disc and into countershaft.
4. Install brake disc cover (52) over studs and against brake retainer, secure with nuts.

CAUTION: Be sure brake plates (51) are in alignment with dowels also that brake springs (48) are in proper position before tightening stud nuts.

CLUTCH HOUSING AND ANGLE DRIVE GEAR INSTALLATION

NOTE: If it should be necessary to replace clutch housing or transmission main case, remove two dowel pins, then bolt clutch housing to transmission case. Drive gear bearing retainer (37, fig. 15) will serve to properly align housing with case. Drill and line ream dowel pin holes to accommodate oversize dowel pins. Separate the parts and install oversize dowel pins in transmission case. Provide counterbores in clutch housing to accommodate snap rings.

Procedure following includes instructions for installing clutch housing, bevel drive gears, and procedure for setting gears for proper tooth contact.

Key numbers in text refer to figure 15 unless otherwise indicated.

Adjusting Bevel Drive Gear Bearing Pre-Load

1. Install spacer (9, fig. 17), bevel drive gear (18) on drive gear (27).
2. Place O-ring seal (11, fig. 17) in groove in drive gear bearing retainer (10, fig. 17) and place clutch housing gasket at transmission case; then install clutch housing on studs and into contact with gasket. Install flat washers and stud nuts on clutch housing-to-transmission studs. Tighten stud nuts evenly and firmly. Stud nuts are self-locking type. Two studs are in clutch housing and nuts are installed at flange on transmission case.
2. Install inner bearing assembly (24), so bearing cone contacts solidly at gear. Place spacer (28) (0.394" thick, #2419742) and a combination of shims to provide total thickness of 0.433 inch on drive gear (27). With inner and outer bearing cups (23 and 30) in place in bearing retainer, assemble retainer to clutch housing using original shims (19) between retainer and housing. Use suitable spacers and nuts on studs to hold retainer firmly to housing.
3. Install outer bearing assembly (29) and nut (25) on drive gear (27) and tighten nut (25) to torque listed in "Specifications" at end of this section.
4. Mount dial indicator on retainer stud and check amount of end play in drive gear (27).
5. Shift sliding clutches to neutral and check torque required to rotate drive gear. This can be done with spring scale and string wrapped around nut (25). This rotating torque (without bearing pre-load) must be known in order to compute the amount of pre-load after changing shims as instructed in step 7 following.
6. Remove nut (25), outer bearing assembly (29), and spacer (28) and shims.
7. Determine correct shim pack to use as follows:

Add 0.002 inch to the amount of end play found in step 4. above; then subtract this sum from the 0.433 inch dimension specified in step 3. above. The result is the correct total thickness of spacer and shims to use to produce required bearing pre-load of 5 to 15 inch-pounds.

8. Select the combination of shims and spacer (28) to give total thickness specified above, then reassemble spacer (28) shims, outer bearing assembly (29), and nut (25). Tighten nut to torque specified in listing at end of section.
9. Determine drive gear bearing pre-load using spring scale and string wrapped around nut (25). Pre-load on bearings will be total pull required above minus the pull required to rotate drive gear (step 5.). This result will be from 3.5 to 11 pounds if bearing pre-load is correct.

NOTE: The bevel pinion (5) should not be assembled to clutch housing while making the foregoing check.

If proper pre-load is not obtained, a change in spacer thickness is necessary. Changing the shim pack 0.001 inch will result in a change of 3 inch-pounds pre-load.

10. Stake bearing retaining nut (25) when proper pre-load is obtained. After bearings are properly adjusted, proceed to install bevel pinion and

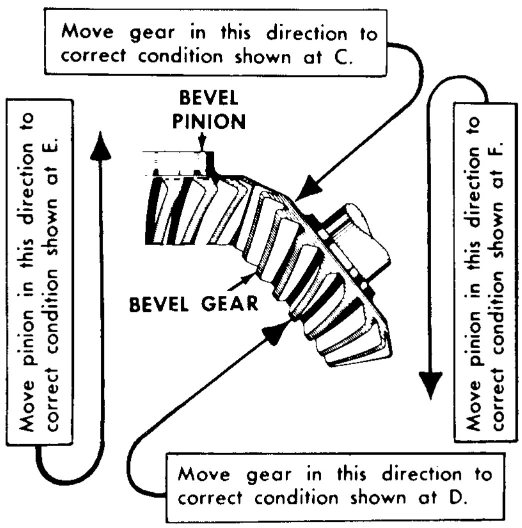
INSTRUCTIONS

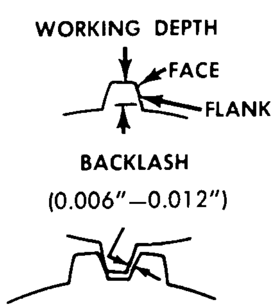
1—Install bevel pinion and bevel gear assemblies; then adjust pinion and bevel gear for proper backlash as directed in "Bevel Gear and Pinion Adjustments" paragraph of this section.

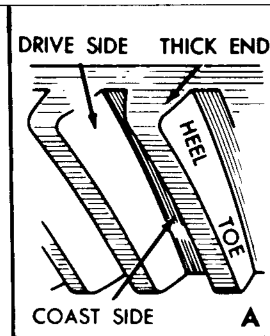
2—Paint three or four teeth of bevel gear with red lead or mechanics blue and rotate bevel gear in direction of rotation until pinion makes complete revolution.

3—Note area of tooth contact which should start at toe and extend about 80 percent of tooth length toward heel, as at B.

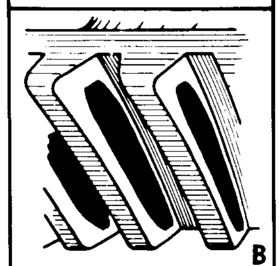
4—Vary position of pinion and gear as per chart until proper tooth contact is obtained. Be sure that sufficient backlash has been allowed so that gear can be completely revolved without any highspots being felt.





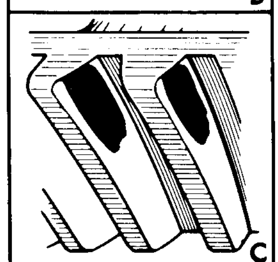


A—Check tooth Contact Pattern at drive side of BEVEL GEAR tooth

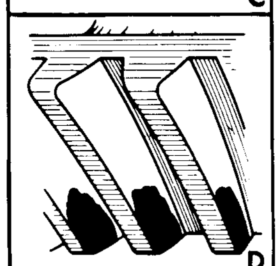


B—Shows correct tooth contact

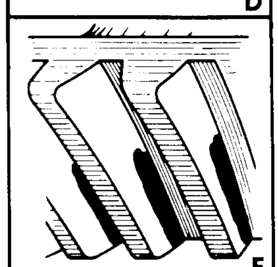
NOTE: Key Numbers Below Refer to Figure 15



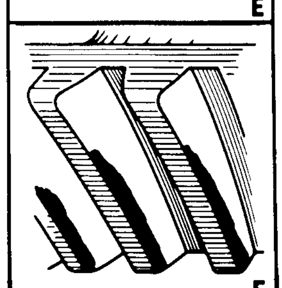
C—Shows short contact at heel. To correct, increase thickness of shims (19) to move gear toward pinion. Then increase thickness of shims (41) to move pinion away from gear to again secure correct backlash.



D—Shows short contact at toe. To correct, decrease thickness of shims (19) to move gear away from pinion. Then decrease shim thickness (41) to secure correct backlash.



E—Shows heavy contact on flank or lower portion of tooth. To correct, increase thickness of shims (41) to move pinion away from gear until contact comes to full working depth of gear tooth without breaking contact at flank. Then increase thickness of shim (19) to move gear toward pinion to secure correct backlash.



F—Shows heavy contact on face or upper portion of tooth. To correct, decrease thickness of shims (41) to move pinion toward gear until contact covers flank of tooth without breaking contact at face. Then decrease thickness of shims (19) to move gear away from pinion to secure correct backlash.

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Figure 19—Gear Tooth Contact Chart

bearing assembly and set up gears for correct tooth contact and backlash.

INSTALLING BEVEL PINION
AND BEARING ASSEMBLY

Key numbers in text refer to figure 15.

1. Locate original shims (41) at flange of retainer (37), then install bevel pinion and bearing assembly in clutch housing and install bearing retainer bolts (43). With transmission in neutral, try turning bevel pinion (5) as bolts (43) are tightened. If any binding is noted it may be due to insufficient backlash between bevel gears (17 and 18). Backlash can be increased by adding shims (41) at retainer flange and backlash must be from 0.006 to 0.012 inch.

2. Check bevel gear backlash with dial indicator. Mount a C-clamp on bevel pinion shaft and mount dial indicator on clutch housing. Set stem of indicator at a point on clamp 2-1/8 inches from surface of pinion shaft. Note on indicator dial the amount shaft can be rotated without moving bevel gear (12).

NOTE: When necessary to change backlash, a change of 0.002 inch in shim pack will change backlash 0.001 inch.

3. Check gear tooth contact. The outside shims (gaskets) in shim pack (19) are aluminum. These should be replaced with new parts when assembling transmission. Remove square head filler plug at top of housing above bevel gears. Use a suitable applicator and apply a thin even coat of red lead on bevel gear teeth. Rotate bevel pinion shaft in same direction as in normal operation, while applying tension at propeller shaft flange. After rotating gears to produce a clear contact impression at drive side of bevel gear teeth (fig. 19), observe contact area through filler plug hole.

a. Tooth contact impression should start at toe of tooth and extend back about 80% of tooth length toward heel on drive side of tooth. Contact should be distributed evenly over flank of tooth indicating center of contact below pitch line. Refer to diagrams "A" and "B" in figure 19.

b. If tooth contact is short and too far out on heel of tooth (diagram "C" figure 19), increase thickness of shims (19) between bearing retainer (22) and housing (33), moving gear (18) toward pinion (5). Restore backlash by increasing shims (41) between bearing retainer (37) and housing (33).

CAUTION: When necessary to add shims (19) between retainer (22) and housing, it is important to measure space at point "A" (fig. 16) to determine if drive gear (27) is being pulled too far forward. If space between drive gear and clutch gear (15 and 86, fig. 17) exceeds 0.170 inch, there is danger of rollers in bearing (12, fig. 17) riding against shoulder in bearing outer race. To correct this condition a thicker spacer (9, fig. 17) must be used.

c. If tooth contact extends back from toe appreciably less than 80% of tooth length (diagram "D" fig. 19), move gear (18) away from pinion (5) by decreasing shims (19). Restore backlash by decreasing shims (41).

d. If contact is low on flank of tooth (see diagram "E" fig. 19), move pinion (5) away from gear (18) by increasing shims (41). Restore backlash by increasing shims (19).

e. If contact is high on face of tooth (diagram "F" fig. 19), move pinion (5) toward gear (18) by decreasing shims (41). Restore backlash by decreasing shims (19).

5. After tooth contact and backlash have been adjusted, install bearing cap assembly (31) using new gasket (20).

TRANSMISSION CONTROL
COVER INSTALLATION

1. Move the four sliding clutches (3, 11, 4 and 16, fig. 16) to neutral position and locate new cover gasket on transmission case.

2. Shift forks in cover (fig. 18) to neutral position, then carefully lower the cover assembly into place with forks entering grooves in respective sliding clutches.

3. Install cover bolts and lock washers.

4. Mount reverse solenoid and solenoid lever as shown in figure 1, and adjust solenoid linkage as previously directed under "Maintenance."

5. Install speedometer adapter and sending unit.

SPECIFICATIONS

GENERAL DATA

Make	Spicer
Model	7145VK
Speeds	4 Forward—1 Reverse
Mounting	On Power Plant
Gear Selection	Manual, Remote Control

GEAR RATIOS

Angle Drive Gears	.808 to 1
First Speed	4.28 to 1
Second Speed	2.50 to 1
Third Speed	1.50 to 1
Fourth Speed	1.00 to 1
Reverse	3.56 to 1

GEAR BACKLASH

Angle Drive Gears	0.006″-0.012″
Mainshaft to Countershaft Gears	0.006″-0.011″
Mainshaft Gears to Mainshaft	
1st Gear	0.004″-0.007″
2nd Gear	0.004″-0.007″
3rd Gear	0.004″-0.009″
Sliding Clutches and Clutch Gears	0.004″-0.007″

MAINSHAFT

Diameter at 1st Gear	2.6540″-2.6545″
Diameter at 2nd Gear	2.6540″-2.6545″
Diameter at 3rd Gear	2.2545″-2.2550″

COUNTERSHAFT

Diameter at 1st Gear	2.3550″-2.3560″

MAINSHAFT GEARS

Inside Diameter	2.9055″-2.9060″

REVERSE IDLER GEAR

Inside Diameter	1.7505″-1.7515″

MAINSHAFT GEAR BEARING ROLLERS

Number of Rollers per Gear	138
Roller Length	0.655″-0.675″
Lapped Diameter	0.12500″-0.12525″

BEARING ADJUSTMENTS

Bevel Drive Gear Tapered Bearing	See Instructions in Text

BEARING SPACER THICKNESS (Service)

Bevel Pinion Bearings	0.395″
Drive Gear Bearings	0.394″

BEARING ADJUSTING SHIMS

Thicknesses Available	0.003″, 0.005″, 0.010″, 0.020″
Bearing Preload (Rotating Torque)	
Bevel Pinion Bearings	10 to 30 in.-lbs.
Bevel Drive Gear Bearings	10 to 30 in.-lbs.

BEARING RETAINER SHIMS (for adjusting gear tooth contact)

Necessary Space at Point "A", Fig. 16—See Text.	
Minimum	0.060″
Maximum	0.170″
Thrust Washer Thickness	
Reverse Gear	
Front	0.182″-0.187″
Rear	0.185″-0.187″
Countershaft 1st Speed Gear	0.245″-0.249″
Mainshaft 1st Speed Gear	0.471″-0.473″

COUNTERSHAFT 1ST SPEED GEAR BUSHING

Inside Diameter (as serviced)	2.346″-2.349″
Inside Diameter (in place)—Grind to	2.3595″-2.3605″

TRANSMISSION OIL PUMP

Make	John S. Barnes Corp.
Type	Positive Displacement (Gears)
Capacity (at zero psi, 600 rpm)	1.3 gpm
Operating Pressure	80 psi
Gear Length	0.999″-0.9992″
Pump Body Counterbore	
Depth	1.0005″-1.001″
Diameter	1.1660″-1.1667″

TRANSMISSION OIL FILTER

Make	AC
Type	Full Flow w/Bypass Valve
Element Type	Disposable
Element Type No.	PF-7
Bypass Valve Opens at	4.5 to 5.5 psi

TRANSMISSION LOW OIL PRESSURE SWITCH

Make	Fasco Industries, Inc.
Circuit Opens at	2 to 4 psi
Vendor Number	455-T

REVERSE SOLENOID

Make	Delco-Remy
Model No.	001535
Volts to Operate	12
Current Draw (Amps)	
Both Windings	49.5 to 56.7
Hold-in Winding	9.53 to 10.5

1ST AND REVERSE SHIFT MECHANISM

Shift Fork to Sliding Clutch Clearance	
Mainshaft Sliding Clutches	0.005″-0.016″
Reverse Gear Sliding Clutch	0.005″-0.016″

TORQUE WRENCH SPECIFICATIONS—Ft.-Lbs.

Companion Flange Nut	500-550
Mainshaft Nut	300-350
Countershaft Rear Nut	300-350
Countershaft Front Nut	300-350
Drive Gear Outer Bearing Nut	300
Bevel Pinion Bearing Nut	500
Bevel Pinion Bearing Cap Bolts	30
Bevel Pinion Bearing Retainer Bolts	36
Bevel Pinion Bearing Cap Lock Bolts	20
Drive Gear Bearing Retainer Bolts	36
Oil Filter Adapter Bolt	35-40
Oil Filter Mounting Bracket Bolt	35-40
Oil Filter Element	10-15
Shift Lever Studs (in cover)	240
Stud Nuts	
Mainshaft Rear Bearing Cap	35-43
Countershaft Rear Bearing Cap	53-66
Bevel Drive Gear Bearing Cap	27-32
Oil Reservoir	27-32
Clutch Housing	127
Transmission Cover	27-32

Refer to LUBRICATION (SEC. 13) for recommended lubricant and intervals of application.

Propeller Shaft

Propeller shaft, used to transmit power from transmission to differential, is tubular type as shown in figure 1. Propeller shaft is equipped with heavy duty needle bearing universal joints. Yoke at slip joint end is splined and is secured to transmission mainshaft with a washer, nut, and cotter pin. A steel dust cap which screws onto slip yoke (fig. 1) prevents entry of dust.

Flange yoke at rear axle is bolted to drive pinion companion flange. Propeller shaft is welded to end yoke at fixed joint end. Slip joint at transmission end of shaft compensates for variation in distance between transmission and differential. These variations are brought about by the rise and fall of the rear axle as the vehicle passes over uneven ground.

LUBRICATION

Universal joint journals are drilled and provided with lubrication fittings, through which lubricant travels to all four oil reservoirs and then, through a hole in side of each reservoir, direct to bearing assemblies. Bearing assemblies are protected against lubricant leakage and the entry of dust by oil seals. Splines of slip joint are lubricated through lubrication fitting installed in slip yoke.

Universal joints and slip yoke splines should be lubricated periodically as specified in LUBRICATION (SEC. 13).

PROPELLER SHAFT AND UNIVERSAL JOINT REMOVAL

Slip yoke and shaft are marked with arrows (fig. 1) to insure correct alignment at assembly. Make sure arrows are clearly discernible before disconnecting slip joint. If arrows are not visible, mark yoke and shaft distinctly.

To remove the propeller shaft from the vehicle when the axle and transmission are in place, proceed as follows:

1. Remove lock wire, nuts, lock washers, and bolts attaching propeller shaft flange yoke to drive pinion companion flange (fig. 2).
2. Disconnect slip yoke from transmission splined yoke (fig. 3) by removing two bearings from splined yoke as directed in steps 1 through 3 under "Universal Joint Disassembly."
3. Manipulate propeller shaft as necessary to remove from rear side of bulkhead.
4. To separate slip yoke from shaft, unscrew dust cap from slip yoke and pull yoke off splined stub shaft.

UNIVERSAL JOINT DISASSEMBLY

(Refer to Figure 1)

The following procedures apply to both the slip and fixed universal joint assemblies.

1. Use a chisel or screwdriver and bend ends of lock straps (3) away from cap screws (2), then

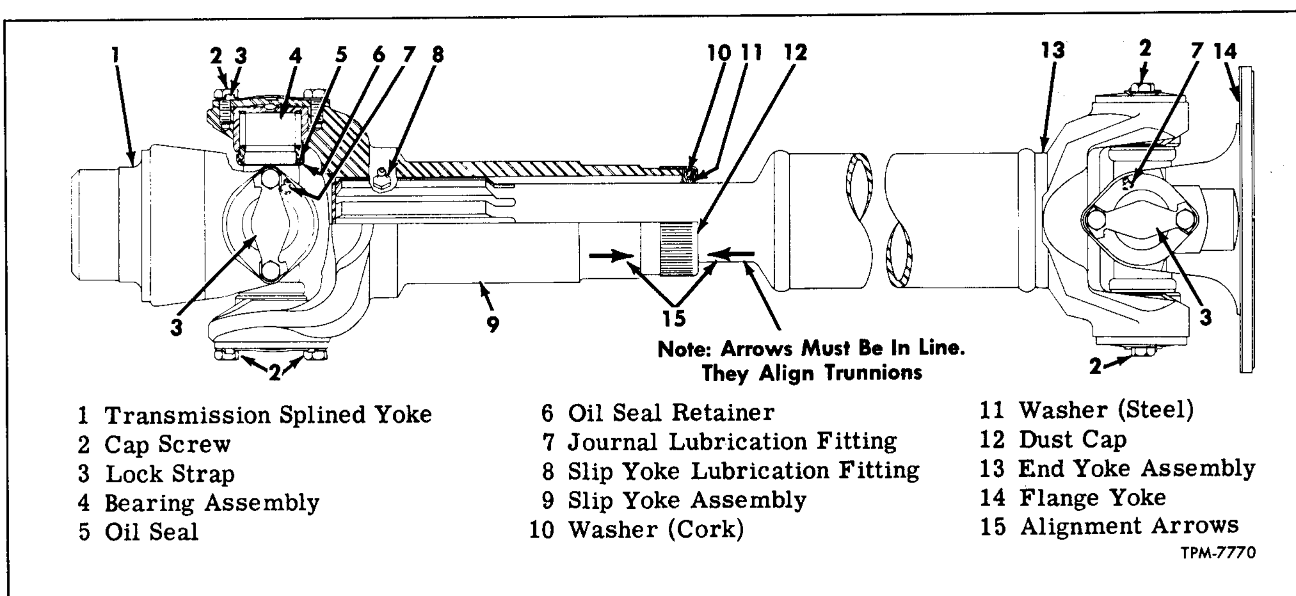

Figure 1—Propeller Shaft and Universal Joint

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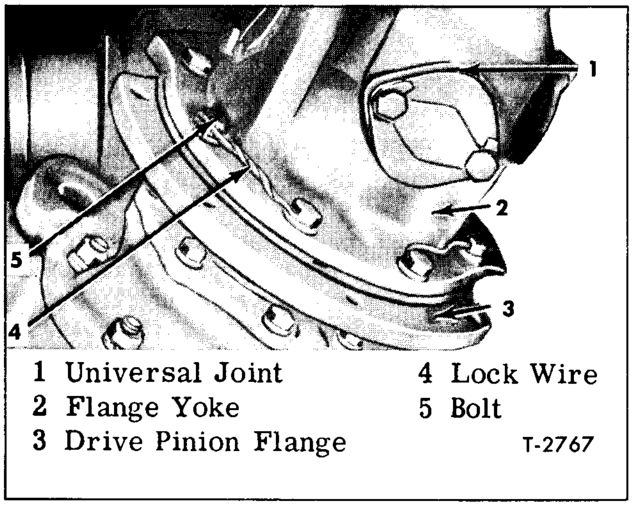


Figure 2—Propeller Shaft Installation at Rear Axle

remove cap screws and lock straps.

2. Strike one side of yoke with hammer to force one bearing out of yoke; strike opposite side of yoke to force opposite bearing out.

3. Journal can now be tilted to permit removing journal from yoke.

4. Remove the other two bearings in the same manner to permit removing journal from othei yoke.

5. Slide oil seals from journal. Remove lubrication fitting from journal. Unless oil seal retainers (6) are to be replaced, do not remove retainers from journals.

CLEANING AND INSPECTION

PROPELLER SHAFT

Use a wire brush and clean all dirt and old lubricant from splines on shaft. Inspect for broken or bent splines. Check shaft for warpage or breaks. If warped or broken, it should be replaced. Welding of broken shafts is not recommended.

SLIP AND FIXED JOINT YOKES

Inspect each yoke for cracks, wear, damage, or bent condition.

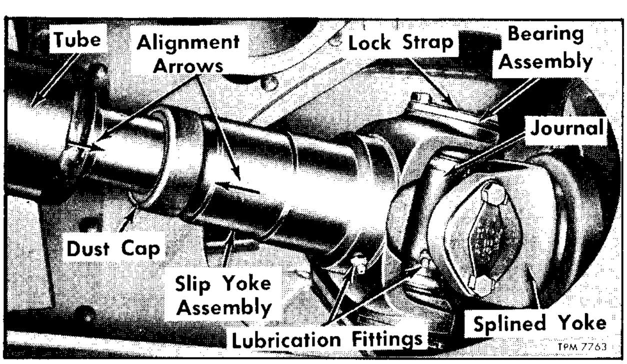


Figure 3—Propeller Shaft Installation at Transmission

Small burrs or rough spots can usually be removed with a hone. See "Specifications" at end of this section for clearance between shaft and yoke splines. Replace worn parts as necessary.

UNIVERSAL JOINTS

Wash all parts with suitable cleaning fluid. Clean all lubricant passages in journals and lubrication fitting. Soak bearing assemblies in cleaner to soften particles of hard grease. Clean bearing assemblies thoroughly, then blow out dirt with compressed air.

IMPORTANT: Be sure that bearing assemblies are clean. Small particles of dirt or grit can cause excessive bearing wear.

Do not attempt to disassemble bearing assemblies. Inspect journal bearing surfaces for roughness or needle bearing grooves. If grooves and roughness will not smooth out with moderate honing, journal and bearing assemblies should be replaced. Check each bearing assembly for wear and missing rollers (see "Specifications" at end of this section). If rollers drop out of bearing, bearing assemblies should be replaced. After bearing assemblies are thoroughly clean, pack with clean grease and turn on journal to check wear.

If excessive clearance is noted, further check of parts is necessary to determine which parts to replace. Inspect oil seal and oil seal retainer and replace if not in good usable condition.

UNIVERSAL JOINT ASSEMBLY

(Refer to Figure 1)

The following procedures apply to both the slip and fixed universal joint assemblies.

1. Install lubrication fitting in journal. If oil seals (5) and oil seal retainers (6) were removed, install oil seal retainers and oil seals on journals.

2. Insert one end of journal into yoke as far as possible from inside and tilt until opposite end of journal clears yoke and drops into position.

3. Insert bearing assemblies (4) from outside of yoke and tap into place with a rawhide or plastic hammer. Do not use steel hammer for this purpose.

4. Joints should move freely in the bearing assemblies and not bind. If joints are too tight, change bearing assemblies around until joints are free and operate smoothly in the assembled position.

5. Install new lock straps (3) and cap screws (2). Tighten cap screws, then bend ends of lock straps against heads of cap screws.

PROPELLER SHAFT INSTALLATION

1. Install dust cap, steel washer, and cork washer (12, 11, and 10, fig. 1) over splined stub shaft.

2. Lubricate shaft splines with lubricant recommended in LUBRICATION (SEC. 13), then install slip yoke on splined shaft with alignment arrows aligned. Thread dust cap onto slip yoke and tighten hand tight.

3. Insert axle end of propeller shaft assembly through opening bulkhead from rear side, then manipulate shaft into position.

4. Connect shaft at transmission splined yoke by installing two bearing assemblies as previously directed under "Universal Joint Assembly."

5. Position flange yoke at drive pinion companion flange and attach with eight bolts, lock washers, and nuts. Tighten firmly, then thread lock wire through bolt heads and twist ends of wire together.

SPECIFICATIONS

Universal Joint (Slip Joint End)	1701 Series
Universal Joint (Fixed Joint End)	1708 Series
Shaft Diameter	3½″
Journal Bearing Surface Diameter	1.3201″-1.3206″
Bearing Rollers	
Number of Rollers	36
Diameter	⅛″
Length	0.920″-0.925″
Slip Joint	
Yoke Spline Thickness	0.3885″-0.3900″
Shaft Spline Thickness	0.3855″-0.3870″
Clearance—Shaft Splines to Slip Yoke Splines	0.0015″-0.0045″

Propeller shaft must be assembled with alignment arrows matched, otherwise excessive vibration and premature wear will result.

Hubs, Wheels, and Tires

This group includes two sections covering maintenance information on "HUBS AND BEARINGS" and "WHEELS AND TIRES."

Hubs and Bearings

Wheels and hubs are carried on two opposed tapered roller bearings as shown in figures 1 and 2. Bearings are adjustable for wear. Satisfactory operation and long life of bearings depend upon proper adjustment and correct lubrication. If bearing adjustment is too tight, bearings will overheat and wear rapidly. Loose adjustment of bearings will result in pounding and will contribute to steering difficulties, uneven tire wear, and inefficient brakes. Before checking or adjusting wheel bearings, always be sure brakes are fully released and not dragging. Wheel studs are installed in hub flange as shown in figures 1 and 2. Brake drums are mounted over wheel studs on outer side of hub flange and attached to hub with countersunk screws.

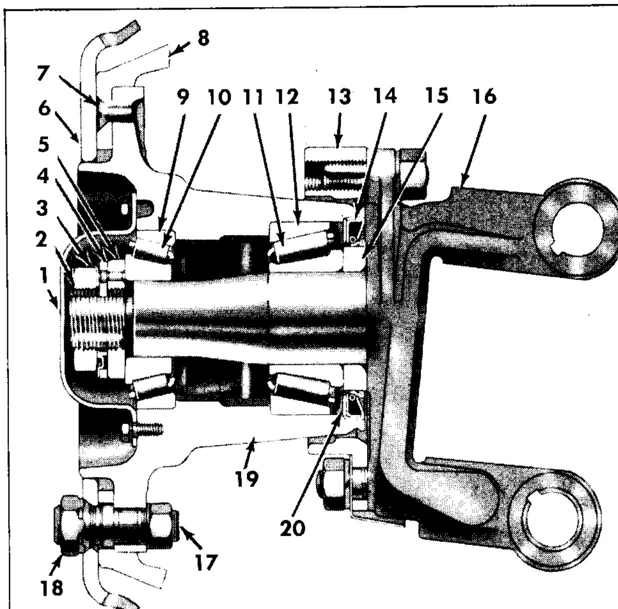
BEARING ADJUSTMENT

Wheel bearing adjustment should be checked carefully at each inspection period. Jack up wheels one at a time and check bearing play by using a pry bar under tires. Observe movement of brake drum in relation to brake spider or brake shoes. If bearings are adjusted correctly, movement of brake drum will be just noticeable and wheel will turn freely with no drag. If test indicates that adjustment of bearings is necessary, make adjustments as follows:

FRONT WHEEL BEARINGS

Key numbers in text refer to figure 1.

1. Remove cap screws and lock washers which attach hub cap (1) to hub (19); then remove hub cap and gasket.
2. Raise lip of nut lock (3) and remove lock nut (2), nut lock (3), and lock ring (4) from steering knuckle spindle (16).
3. Tighten wheel bearing adjusting nut (5) until wheel binds, at the same time turning wheel to make sure all surfaces are in proper contact.
4. Back off bearing adjusting nut (5) 1/6 turn, or more if necessary, making sure wheel turns freely.
5. Position lock ring (4) on steering knuckle spindle, with dowel pin in adjusting nut (5) inserted into hole of lock ring (4). Either side of ring may be turned toward adjusting nut. When installing lock ring, place first one side then the other toward adjusting nut to determine which position will permit dowel pin in nut to line up with hole in ring with least change in position of adjusting nut.
6. Install nut lock (3) and lock nut (2) on steering knuckle spindle. Draw lock nut up tight.
7. Recheck wheel bearing adjustment as described previously; then bend lip of nut lock (3) down against flat of lock nut (2).
8. Position hub cap (1) and new gasket against hub and attach with cap screws and lock washers.



1 Hub Cap	11 Inner Bearing Cone and Roller Assy.
2 Lock Nut	12 Inner Bearing Cup
3 Nut Lock	13 Brake Spider
4 Adjusting Nut Lock Ring	14 Oil Seal
5 Bearing Adjusting Nut	15 Bearing Spacer
6 Wheel	16 Steering Knuckle
7 Brake Drum Retaining Screw	17 Wheel Stud
8 Brake Drum	18 Wheel Nut
9 Outer Bearing Cup	19 Hub
10 Outer Bearing Cone and Roller Assy.	20 Oil Seal Washer

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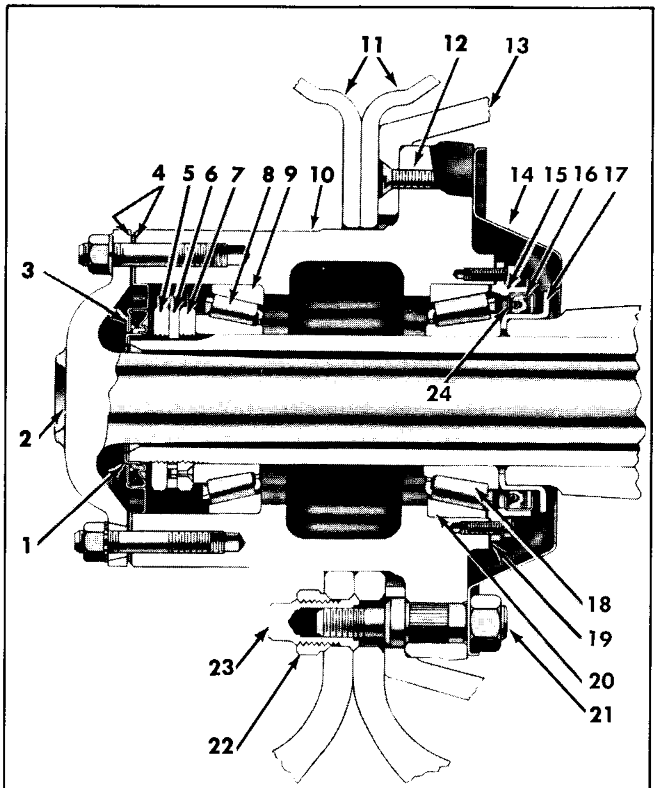
Figure 1—Front Hub, Bearings, and Oil Seals



1 Oil Seal Wiper and Cork Assy.
2 Axle Shaft
3 Outer Oil Seal Assy.
4 Gaskets
5 Lock Nut
6 Lock Ring
7 Adjusting Nut
8 Outer Bearing Cone and Roller Assy.
9 Outer Bearing Cup
10 Hub
11 Wheels
12 Brake Drum Retaining Screw
13 Brake Drum
14 Oil Slinger
15 Inner Oil Seal Retainer
16 Inner Oil Seal
17 Inner Oil Seal Wiper
18 Inner Bearing Cone and Roller Assy.
19 Gasket
20 Inner Bearing Cup
21 Wheel Stud
22 Outer Wheel Nut
23 Inner Wheel Nut
24 Oil Seal Washer

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Figure 2—Rear Hub, Bearings, and Oil Seals

REAR WHEEL BEARINGS

Key numbers in text refer to figure 2.

1. Remove axle shaft as directed in REAR AXLE (SEC. 2) of this manual.
2. Remove gaskets (4) and wheel bearing outer oil seal (3) from axle shaft flange studs.
3. Remove wheel bearing outer oil seal wiper and cork assembly (1) from end of axle housing tube.
4. Unscrew lock nut (5) and remove adjusting nut lock ring (6) from axle housing tube.
5. Tighten wheel bearing adjusting nut (7) until wheel binds, at the same time turning wheel to make sure all surfaces are in proper contact.
6. Back off adjusting nut (7) 1/6 turn, or more if necessary, to make sure wheel turns freely.
7. Position lock ring (6), with dowel pin in adjusting nut (7) inserted in hole of lock ring (6). Either side of ring may be used toward adjusting nut. When installing lock ring (6), place first one side then other side of ring toward adjusting nut (7) to determine which position will permit dowel pin in nut to line up with hole in lock ring with least change in position of adjusting nut.
8. Install lock nut (5) and tighten firmly; then recheck bearing adjustment.
9. Press oil seal wiper and cork assembly (1) on end of axle housing tube.
10. Place new inner gasket (4) on hub over axle shaft flange studs.
11. Coat lip of outer oil seal (3) and oil seal wiper (1) with grease; then install oil seal (3) with holes in retainer over axle shaft flange studs. If oil seal is damaged or worn, even slightly, use a new oil seal.
12. Position new outer gasket (4) on hub (10) over axle shaft flange studs.
13. Install axle shaft as directed in REAR AXLE (SEC. 2) of this manual.

OIL SEALS

Front and rear hubs have oil seals at inner end to prevent leakage of wheel bearing lubricant from hubs into brake drums. Inner oil seals also prevent water and dirt from entering hubs and contaminating wheel bearing lubricant. Oil seals at outer ends of rear hubs prevent rear axle differential lubricant from entering hubs and mixing with wheel bearing lubricant.

Inner seals used in both front and rear hubs are rotating, spring-loaded type. Front seals are pressed into inner end of hub and seal lip wipes on bearing spacer (fig. 1). Rear hub inner seals are pressed into seal retainers which are attached to inner end of hubs with screws; seal lip wipes on a wiper sleeve which is pressed on axle housing tube (fig. 2).

Outer seals used in rear hubs are spring-loaded lip-type seals with integral retainers which fit over axle shaft drive flange studs. Lip of oil seal wipes on oil seal wiper which is pressed onto outer end of axle housing tube. Wiper to tube cork gasket is cemented to inner side of wiper.

At regular inspection periods, examine all seals carefully. If there is the slightest indication of wear, deterioration, or damage at sealing surface, a complete new seal assembly should be installed. Examine surface of oil seal wiper, wiper sleeve, and bearing spacer against which oil seals bear. Any nicks, scratches, or rough spots on these surfaces will impair efficiency of seals.

Always spread a thin coating of grease on face of oil seal, oil seal wiper, wiper sleeve, and bearing spacer before installing parts in hub.

FRONT HUB AND BEARING REMOVAL

Key numbers in text refer to figure 1.

1. Raise front end of coach until tires just clear floor.
2. Remove wheel stud nuts and remove wheel and tire.
3. Remove brake drum to front hub retaining screws (7); then remove brake drum (8) from hub (19).
4. Remove cap screws and lock washers attaching hub cap (1) to hub, then remove hub cap and gasket.
5. Raise lip of nut lock (3), then remove lock nut (2), nut lock (3), lock ring (4), and bearing adjusting nut (5) from steering knuckle spindle.
6. Pull hub assembly straight off spindle, being careful not to permit outer bearing (10) to fall out of hub.
7. Remove outer bearing cone and roller assembly (10) from hub.
8. Pull inner bearing oil seal (14) and washer (20) out of hub, then lift inner bearing cone and roller assembly (11) from hub.
9. Perform cleaning and inspection operations outlined under "Cleaning and Inspection" later in this section. If inspection indicates need for replacing inner and outer bearing cups (12 and 9), they may be driven out of hub by using a long brass drift and hammer through opposite end of hub.
10. If necessary to remove bearing spacer (15), drive a chisel between inner edge of spacer and steering knuckle spindle (16) to force spacer out far enough to permit use of a puller. Be extremely careful not to mar or damage steering knuckle spindle with chisel.

REAR HUB AND BEARING REMOVAL

Key numbers in text refer to figure 2.

1. Jack up vehicle as instructed in "WHEELS AND TIRES" section.
2. Remove 10 outer wheel nuts (22) and 10 inner wheel nuts (23), then remove wheels and tires.
3. Remove five brake drum to hub retaining screws (12); then remove brake drum (13) from hub (10).
4. Remove axle shaft (2) as directed in REAR AXLE (SEC. 2) of this manual.
5. Remove wheel bearing outer oil seal (3) and gaskets (4) from axle shaft flange studs.
6. Remove wheel bearing outer oil seal wiper and cork assembly (1) from end of axle housing tube.
7. Remove lock nut (5), lock ring (6), and adjusting nut (7) from axle housing tube.
8. Lift hub (10) off axle housing tube, holding hand over outer end of hub to prevent outer bearing from falling out. Remove outer bearing cone and roller assembly (8) from hub.
9. Remove six screws and lock washers attaching inner oil seal retainer (15) to hub (10); then remove inner oil seal and retainer (16 and 15) and gasket (19) from hub.
10. If desired, inner oil seal (16) and washer (24) can be pushed out of seal retainer (15).
11. Lift inner bearing cone and roller assembly (18) out of hub.
12. If necessary to remove oil seal wiper sleeve (17), as indicated under "Cleaning and Inspection" following, use chisel or suitable tool and drive sleeve off axle housing. Be careful not to damage axle housing tube.
13. If necessary to remove bearing cups (9 and 20) from hub (10) as indicated under "Cleaning and Inspection" following, they may be driven out of hub by using a hammer and long brass drift through opposite end of hub.

CLEANING AND INSPECTION

CLEANING

1. Immerse bearing cone and roller assemblies in gasoline or other suitable cleaning solvent. Clean bearings with a stiff brush to remove old lubricant. Blow bearings dry with compressed air, directing air stream at right angles to bearing. DO NOT SPIN BEARINGS WITH AIR PRESSURE.
2. Thoroughly clean all old lubricant out of inside of hub and wipe hub dry. Make sure all particles of old gasket are removed from inner end of hub.
3. Clean all lubricant off rear axle housing tube or front axle spindle. Wipe lubricant off oil seals, using a clean cloth dampened with cleaning solvent. Do not permit cleaning solvent or grease to get on brake linings.
4. Wash all small parts such as bearing nuts, lock rings, and oil seal wipers in cleaning solvent. Wipe parts dry.

INSPECTION

1. Inspect bearing rollers for excessive wear, chipped edges, or other damage. Slowly rotate rollers around cone to detect any flat or rough spots on cone or rollers. Do not mistake dirt or grit for roughness. Replace bearing assemblies if any damage is found.
2. Examine bearing cups in hub. If cups are pitted or cracked, they must be replaced with new parts. Check inside diameter of inner and outer hub cup bores.
3. Carefully examine oil seals for signs of

wear, deterioration, distortion, or damage at the sealing surfaces. Replace oil seal assembly if any of the above conditions are evident.

4. Inspect oil seal wiper, wiper sleeve, or bearing spacer for nicks or rough spots which would cause rapid wear of oil seals. Replace with new parts as necessary.

5. After inspection is completed and parts replaced as necessary, lubricate bearings and inside of hub as directed in LUBRICATION (SEC. 13).

FRONT HUB AND BEARING INSTALLATION

Key numbers in text refer to figure 1.

1. If inner bearing spacer (15) was removed, drive into place on steering knuckle spindle. Make sure spacer is fully seated against knuckle flange.

2. If inner and outer bearing cups (12 and 9) were removed from hub, drive or press new cups into hub with wide side of cups toward inside of hub. Make sure cups are fully seated against shoulder in hub and not cocked.

3. Be sure inner and outer wheel bearings (10 and 11) and inside of hub are lubricated as directed in LUBRICATION (SEC. 13) of this manual.

4. Position inner bearing cone and roller assembly (11) inside hub (19).

5. Place oil seal washer (20) in hub; then press oil seal (14) into hub against washer. Lip of oil seal must point toward inside of hub.

6. Coat face of inner oil seal (14) and bearing spacer (15) with grease.

7. Install hub assembly (19) on front axle steering knuckle spindle. Be careful not to damage wheel bearing oil seal assembly (14).

8. Place outer bearing cone and roller assembly (10) on steering knuckle spindle (16) and push bearing into hub with fingers.

9. Install wheel bearing adjusting nut (5) on steering knuckle spindle. Tighten adjusting nut against outer bearing finger-tight.

10. Position brake drum (8) on flange of hub (19) and attach with retaining screws.

11. Place wheel and tire on hub and attach with stud nuts. Refer to "Wheel Maintenance" in "WHEELS AND TIRES" section for wheel nut torque and tightening procedure.

12. Adjust front wheel bearings and complete the installation as previously directed under "Bearing Adjustment" in this section.

REAR HUB AND BEARING INSTALLATION

Key numbers in text refer to figure 2.

1. If inner oil seal wiper (17) was removed from axle housing, reinstall wiper sleeve on housing.

2. If inner and outer bearing cups (9 and 20) were removed from hub (10), drive or press new cups into hub with wide side of cups toward inside of hub. Make sure cups are fully seated against shoulder in hub and not cocked.

3. Lubricate bearings and inside of hub as directed in LUBRICATION (SEC. 13).

4. If inner oil seal (16) was removed from seal retainer (15), install oil seal washer (24) in retainer, then press new oil seal into retainer. Use extreme care when pressing oil seal into place to avoid distorting seal flange.

5. Place inner bearing cone and roller assembly (18) inside hub (10); then position inner oil seal (16) and retainer (15) on inner end of hub (10), using new gasket (19) between retainer and hub.

6. Attach retainer (15) to hub (10) with six screws and lock washers. Tighten screws evenly and firmly.

7. Coat face of oil seal (16) and oil seal wiper (17) with grease.

8. Position hub assembly (10) on axle housing tube, being careful not to damage inner oil seal (16).

9. Place outer bearing cone and roller assembly (8) on axle housing tube. Push bearing into hub with fingers.

10. Install bearing adjusting nut (7) on axle housing tube. Tighten adjusting nut against outer bearing finger-tight.

11. Position brake drum (13) on flange of hub (10) and attach with five retaining screws.

12. Install wheels and tires on hub and attach with wheel stud nuts. Refer to "Wheel Maintenance" in "WHEELS AND TIRES" section for wheel nut torque and tightening procedure.

13. Adjust rear wheel bearings and complete the installation as previously directed under "Bearing Adjustment" in this section.

SPECIFICATIONS

Front Wheel Hub	
Inner Cup Bore	5.341″-5.343″ dia.
Outer Cup Bore	4.874″-4.872″ dia.
Rear Wheel Hub	
Inner Cup Bore	5.900″-5.902″ dia.
Outer Cup Bore	5.741″-5.743″ dia.

Wheels and Tires

JACKING UP VEHICLE

Whenever it is necessary to change a wheel and tire on the road, the following procedures must be followed:

FRONT

1. Turn front wheels to extreme right or left, depending on which tire is flat, so that the front of the flat tire is turned outward.
2. Run flat tire up on run-up block. (Run-up block can be made locally to dimensions shown in figure 1.) Fully apply parking brake.
3. Place jack under front axle center as shown in View B, figure 2, and raise vehicle.
4. Remove run-up block and proceed to change tire. Refer to "Wheel Maintenance" later in this section for wheel nut tightening procedure.
5. Lower jack and remove from under axle center.

REAR

Outside Dual

1. To change outside dual, place wooden run-up block (fig. 1) at inside tire.
2. Drive vehicle onto block to raise outside dual off ground. (View A, figure 2, shows inner dual on run-up block with outer dual removed.)
3. Fully apply hand brake, then proceed to change wheel and tire. Refer to "Wheel Maintenance" later in this section for wheel nut tightening procedure.

Inside Dual

1. To change inner dual, fully apply hand brake.
2. Position jack under suspension support as shown in View C, figure 2.
3. Jack up axle and proceed to change wheel and tire. Refer to "Wheel Maintenance" later in this section for wheel nut tightening procedure.

SPARE TIRE AND COMPARTMENT

Spare tire and wheel is stowed in compartment behind front bumper. Small access door in floor of compartment can be opened to check and inflate spare tire without removing tire and wheel from compartment. NOTE: When tire and wheel is stowed in compartment, make sure that tire valve is toward front of coach so that valve is located near small access door in floor of compartment. Accessory tool (special equipment) is stowed in heating compartment.

REMOVAL FROM COMPARTMENT
(When Vehicle is Equipped With Accessory Tool)

1. Open spare tire compartment by inserting wheel wrench through two openings in bumper and unscrew retaining bolts, one each side. Lower front bumper and compartment door.

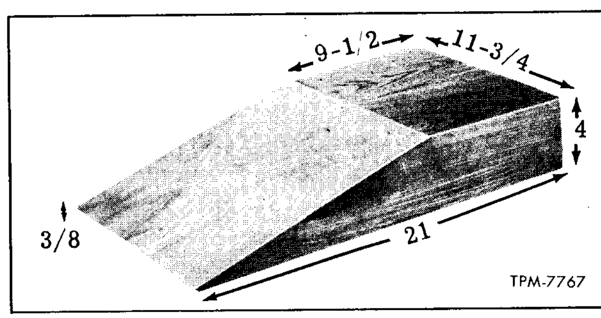

Figure 1—Run-Up Block Dimensions

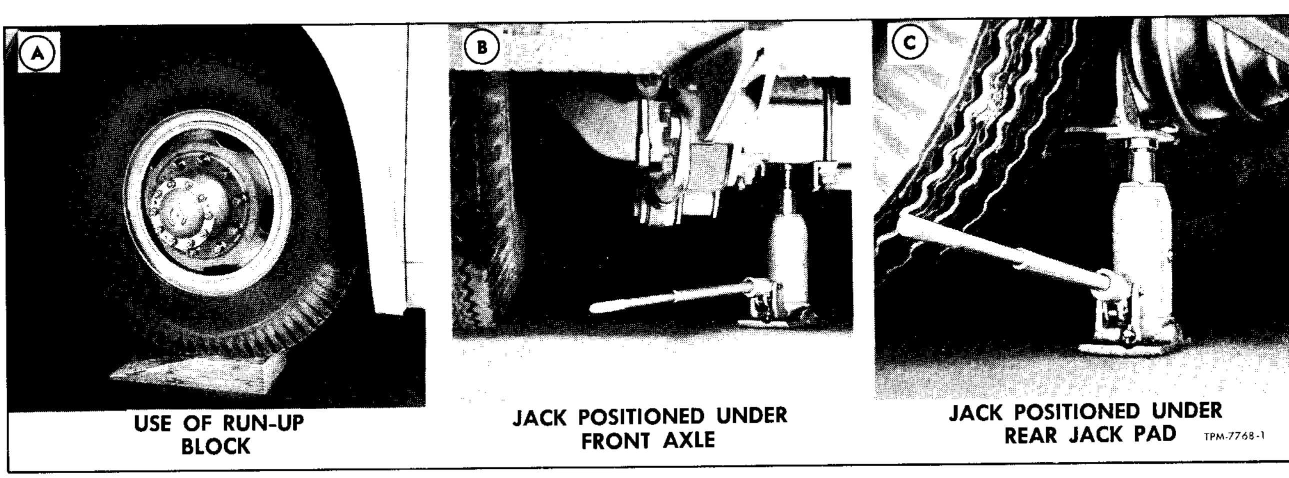

Figure 2—Method of Jacking Up Vehicle

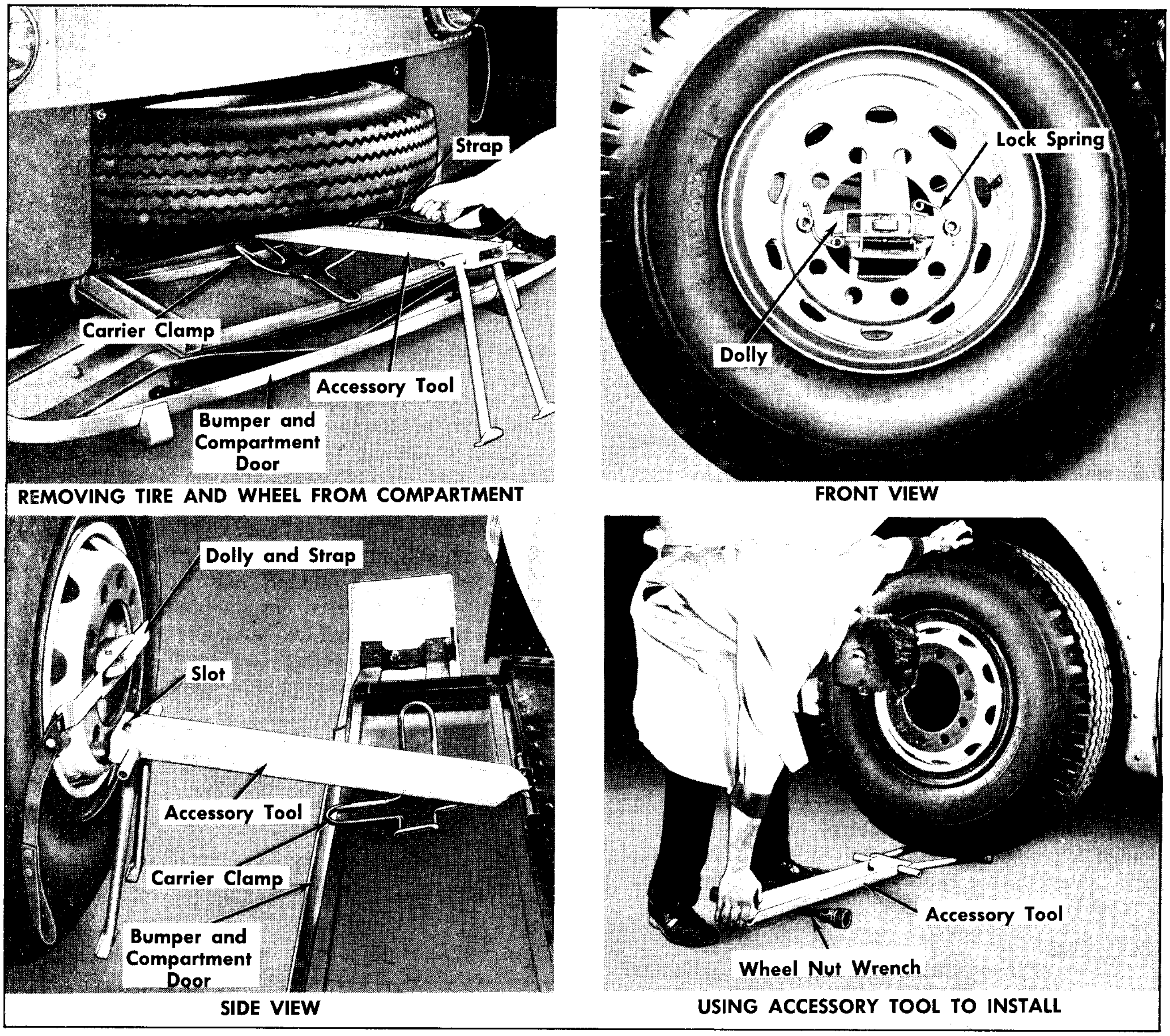

Figure 3—Method of Handling Spare Wheel and Tire (Using Special Accessory Tool)

2. Lower spare tire carrier clamp shown in A, figure 3, then position spare tire accessory tool as shown in C, figure 3.

3. Grasp strap of spare tire dolly (A, figure 3) and pull spare tire with dolly upward and slowly forward until wheel of tire dolly drops into slot in accessory tool (C, fig. 3).

CAUTION: When wheel of dolly approaches slot in accessory tool, use extreme care to prevent wheel from jumping past the slot.

4. Turn tire, wheel, and dolly 1/4 turn and lower tire and wheel to floor as shown in View B, figure 3. Wheel on dolly will engage slot in accessory tool and prevent tire and wheel from slipping off accessory tool and causing injury.

5. Place tire and wheel fully on floor as shown in View C, figure 3, then remove dolly and strap by releasing two lock springs which attach dolly to wheel.

6. Open accessory tool to full length and place wheel nut wrench at lifting end of tool as shown in View D, figure 3, then roll wheel and tire on accessory tool. Lift on end of accessory tool to raise tire and wheel onto hub (View D, figure 3).

INSTALLATION IN COMPARTMENT

1. Position accessory tool as shown in View C, figure 3.

2. Install dolly and strap on wheel by locking two lock springs which attach dolly to wheel as shown in View B, figure 3.

3. Place wheel on accessory tool with dolly in position as shown in View C, figure 3.
4. Turn wheel and tire 1/4 turn so that wheel on dolly will run parallel with accessory tool, then slide wheel, tire, and dolly into compartment as shown in View A, figure 3.
5. Remove accessory tool, then raise tire carrier clamp into proper position. Close front bumper and compartment door and secure with two retaining bolts.
6. Store accessory tool in heating compartment.

WHEEL MAINTENANCE

Wheel studs and nuts on left side of vehicle have left-hand threads. Studs and nuts on right side of vehicle have right-hand threads.

1. Before new vehicle goes into service and after each wheel removal, all wheel stud nuts should be thoroughly tightened. Refer to instructions below for wheel nut torque and wheel nut tightening procedure. See that studs and nuts are free from grease or oil. Do not use oil on studs or nuts.
2. To tighten stud nuts on dual rear wheels, loosen outer nuts, then tighten inner nuts. Tighten opposite nuts alternately so that wheel will be square against hub flange. After tightening inner nuts, tighten outer nuts to specified torque.
3. Re-tighten stud nuts every 100 miles for first 500 miles to offset setting-in of clamping surfaces.
4. Inspect wheel stud nuts at least every 1000 miles thereafter. If vehicle is subjected to severe service, inspection should be made daily regardless of mileage.
5. When changing wheels or tires and before assembling wheels to hubs, remove dirt, grease, and excess paint from the mating surfaces. Dual rear wheels should be positioned with valve stems 180 degrees apart.

NOTE: Cleanliness of wheel and drum mating surfaces is important to proper wheel mounting. On new drums in particular the inner and outer surfaces of the mounting flange should be thoroughly cleaned with solvent to remove the rust preventive coating which is applied for storing and shipping purposes only. This is a wax base substance and should be removed so that solid contact of mating surfaces is obtained.

WHEEL NUT TORQUE

Excessive tightening of wheel stud nuts has proven to be the cause of erratic brake action in some cases. Where excessive torque is applied, brake drum distortion will occur.

Improper procedure in tightening of wheel stud nuts, including excessive torque, has also been found to cause wheel distortion and wheel runout. Such condition will have decided effect on tire life. Wheel nuts should be carefully torqued so that the limits listed in "Specifications" at end of this section are not exceeded. These specifications have proven to be entirely satisfactory to insure wheel tightness and torque applied exceeding these limits is not recommended. To insure correct torque, a large size torque wrench should be used. A number of torque wrenches suitable to this application are available, one of which is made by "Snap-On" in a 0 to 600 foot-pounds capacity with a 3/4" drive. "Snap-On" tool number is TA 602A, and is also available with a light indicator under tool number TQ 602AL. If a pneumatic impact wrench is used for tightening wheel stud nuts, it should be used only for initial "run-in" of nuts in order to allow wheel to correctly position itself on the hub. Final tightening should be done with a torque wrench to insure that all nuts are torqued evenly and not beyond the limits shown herein.

WHEEL STUD NUT TIGHTENING PROCEDURE

It is important that wheel stud nuts be tightened alternately on opposite sides of wheel. A suggested sequence for tightening is shown in figure 4, and a recommended procedure is as follows:

1. Run the stud nuts in lightly, following the sequence shown, so that wheel will position itself concentrically with hub. THIS IS IMPORTANT; OTHERWISE WHEEL MAY BE ECCENTRIC WITH HUB AND WILL NOT RUN TRUE. In this initial step, run the nuts up only as necessary to correctly position wheel.
2. Tighten nuts progressively in the sequence shown in figure 4 with torque wrench until torque limit is reached. Do not tighten each nut completely at one time, but progress from one nut to another so that wheel is tightened uniformly.

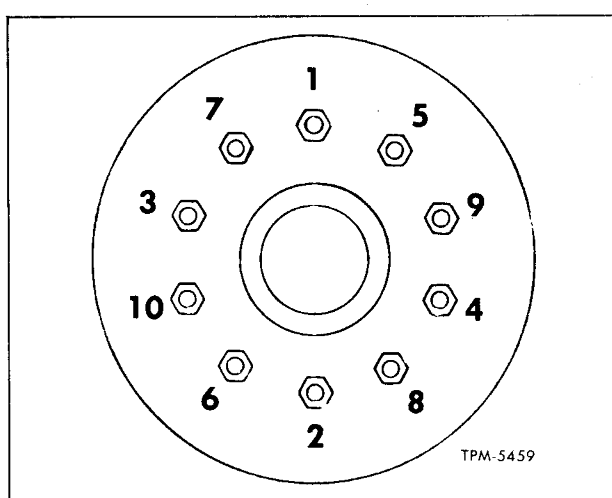

Figure 4—Wheel Nut Tightening Sequence

WHEELS AND TIRES

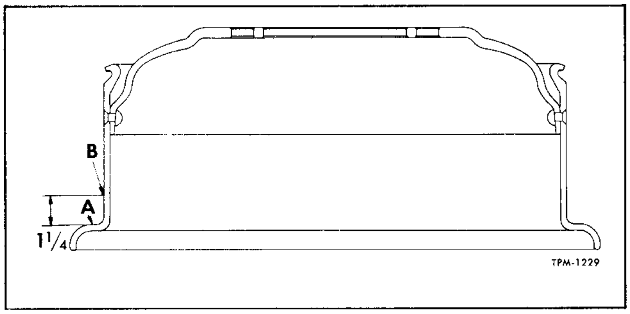

Figure 5—Wheel Checking Diagram

WHEEL INSPECTION

Do not use wheels with bent rims. Continued use of wheels with bent rims will result in excessive tire wear and, if wheel is mounted on front of vehicle, difficulty in steering vehicle will be experienced. Wheels that are thought to be distorted should be checked as follows (see fig. 5):

1. Remove wheel from vehicle and dismount tire.
2. Clean all rust, scale, dirt, and grease from rim.
3. Mount wheel securely in lathe or other suitable fixture. NOTE: Face of hub must run true, as any run-out at that point will be increased from 1-1/2 to 3 times at checking points on rim.
4. Revolve wheel slowly and check at point "A" for lateral run-out (wobble). This should not exceed 3/32-inch. Check at point "B" for radial run-out (out-of-round). This should not exceed 1/8-inch total indicator reading. Wheels that are distorted in excess of these limits should be replaced.

TIRE MAINTENANCE

Coaches are equipped with tubeless tires and rims as standard equipment.

One of the most important factors of economical and safe motor vehicle operation is systematic and correct tire maintenance. Tires must not only support weight of loaded vehicle, but they are also integral parts of the transmission and braking systems. Therefore, tires should receive careful, systematic, and regular maintenance as do other operating units. Three major causes of tire trouble are (1) improper inflation, (2) overloading, and (3) misalignment. Tires should be checked periodically for these conditions.

INFLATION OF TIRES

Improper inflation is the greatest cause for loss of tire life expectancy. Tires should be checked frequently for this condition. Tire fabric, rubber bead, contour, and size used on these vehicles are designed to obtain maximum length of service under all operating conditions to which vehicles may be subjected. TIRES ARE DESIGNED TO OPERATE EFFICIENTLY ONLY ON A PRESCRIBED AMOUNT OF AIR. Unless correct air pressure is consistently maintained, tires will not function as they should; consequently safe, economical operation of vehicle will be materially affected.

Operating air pressure recommended by the tire manufacturer is as essential to safe and economical operation of tire, as proper amount of oil would be to an engine or other chassis units.

An under-inflated tire runs sluggishly, heats up quickly because of greater flexing, and is subjected to more frequent bruising. Over-inflation does not compensate for over-loading. It does not add strength to tire, in fact, it actually weakens the tire by reducing its ability to absorb road shock, and may cause a blow-out.

In addition to the deteriorating effect improperly-inflated tires may have on tire life, improperly-inflated tires will effect steering, riding comfort, and safe driving.

Tires are designed to operate at certain recommended inflations, which provide normal flexing with proper deflection and road contact. If flexing is changed from normal, either by over-inflation, under-inflation, or overloading, proper service from tire cannot be obtained. FOLLOW TIRE PRESSURE RECOMMENDATIONS OF THE TIRE MANUFACTURER.

BALANCED INFLATION

The operating efficiency of vehicle will be seriously upset if air pressures in tires are out of balance. Balanced inflation may be expressed as: all tires on the same axle should always carry same air pressure. A difference in air pressure of rear tires and front tires may be permissible within certain limitations; however, there should not be a difference in pressures between right and left tires on the same axle. A five pound under-inflation in one front tire not only can destroy ease of steering, but creates steering hazards which generally point to a potential accident. An under-inflated rear tire can destroy the value of the most efficient brakes. Balance tire pressures for ease of steering, comfort in riding, safety in driving, as well as for minimum fuel consumption and maximum tire mileage.

PRESSURE LOSS

At periodic intervals, each tire should be gauged for pressure loss with an accurate gauge before tires are brought to correct operating pressure. Purpose of this check is to determine exact pressure losses in each tire. In other words, if at the time this check is made, a definite pressure loss is noted in any one of the tires, an inspection

should be made of tire showing loss and cause of loss corrected. This method should definitely establish a "danger signal" on the condition of tires. Pressure loss check should be made consistently with the same gauge, so that any element of inaccuracy in gauge will be the same for all tires.

TIRE ROTATION

Tires should be interchanged at regular intervals to obtain maximum life. Change wheels without dismounting tires so direction of rotation will be reversed. The following system of interchanging is suggested: Right front to left rear inside or right rear outside. Left front to right rear inside or left rear outside.

If inside dual tires show more wear than outside dual tires, place front tires on inside when changing. In this case, outside dual tires can be interchanged between right- and left-hand side of vehicle.

If outside dual tires show more wear than inside dual tires, place front tires on outside dual tires when changing. At the same time, interchange right- and left-hand inside dual tires.

New tires should be installed on front wheels where they run coolest.

SELECTION OF TIRES

All tires on the same axle should, whenever possible, be of the same make, since differences in design and tread in some instances result in unequal tire rolling radii. It is not possible to match all tires exactly. Therefore, some tolerance must be permitted. When installing tires on a vehicle, all tires on same axle should have the same outside diameter within tolerance limits. The most desirable matching is obtained by not exceeding 3/4-inch difference in circumference or 1/4-inch difference in diameter. If tires do not have the same outside diameter (within 1/4-inch) excessive tread scuffing and hard steering will result. Tire diameters may be measured with a conventional tire measuring gauge.

TUBELESS TIRE VALVES

REMOVAL OF METAL STEM VALVES

1. Remove lock nut and washer.
2. Remove valve from wheel or rim, inspect rubber grommet; if grommet is worn, remove and install new grommet.

INSTALLATION OF METAL STEM VALVES

Position valve in wheel or rim, install washer and lock nut; tighten lock nut.

TORQUE SPECIFICATIONS

Front Wheel Nuts	550-625 ft.-lbs.
Rear Wheel Nuts	
Inner	550-625 ft.-lbs.
Outer	550-625 ft.-lbs.

FOR MAXIMUM TIRE LIFE, FOLLOW THE TIRE PRESSURE RECOMMENDATIONS OF THE TIRE MANUFACTURER.

Heating and Air Conditioning

This group is divided into two sections covering "HEATING and VENTILATION" and "AIR CONDITIONING."

GENERAL DESCRIPTION

The coach heating and air conditioning system is designed to provide passenger comfort by heating or cooling, dehumidifying, and filtering the air which is force-circulated within the coach. The heating and air conditioning systems are entirely independent from each other; however, the entire heating system is utilized to control or temper the air which is cooled by air conditioning. This tempering or temperature-raising process provides the necessary "reheat" phase of the air conditioning system.

Air circulation (fig. 2) for heating and air conditioning is the same for both systems. The heating system units are accessible through access door at right side of coach and through forward baggage compartment bulkhead. Air conditioning units are accessible through doors on either side of coach and through forward baggage compartment bulkhead.

Heating and Ventilation

Interior of coach is heated by an underfloor hot water forced air system.

The heating controls are electrically-operated controls. These controls function to control

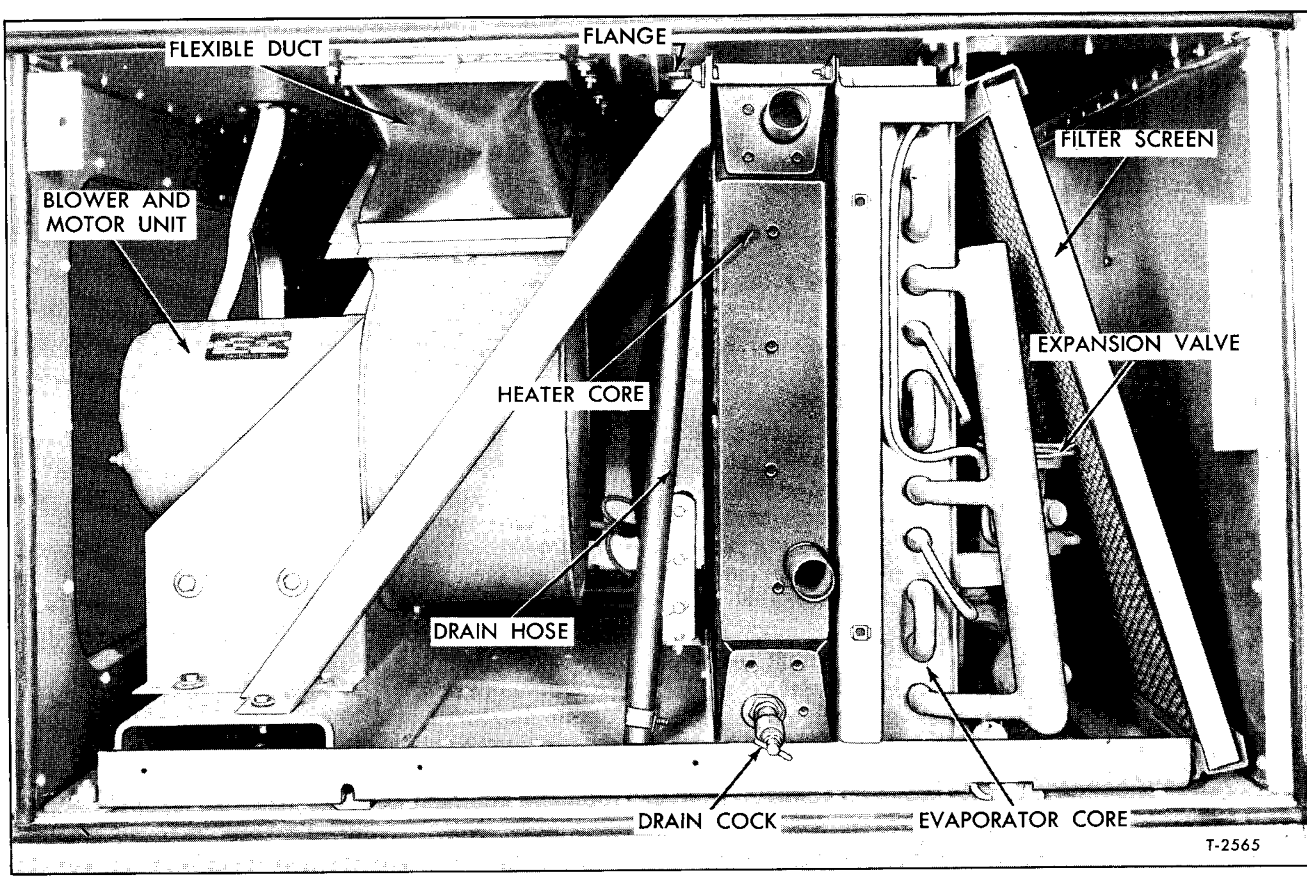

Figure 1—Underfloor Heating and Air Conditioning Compartment

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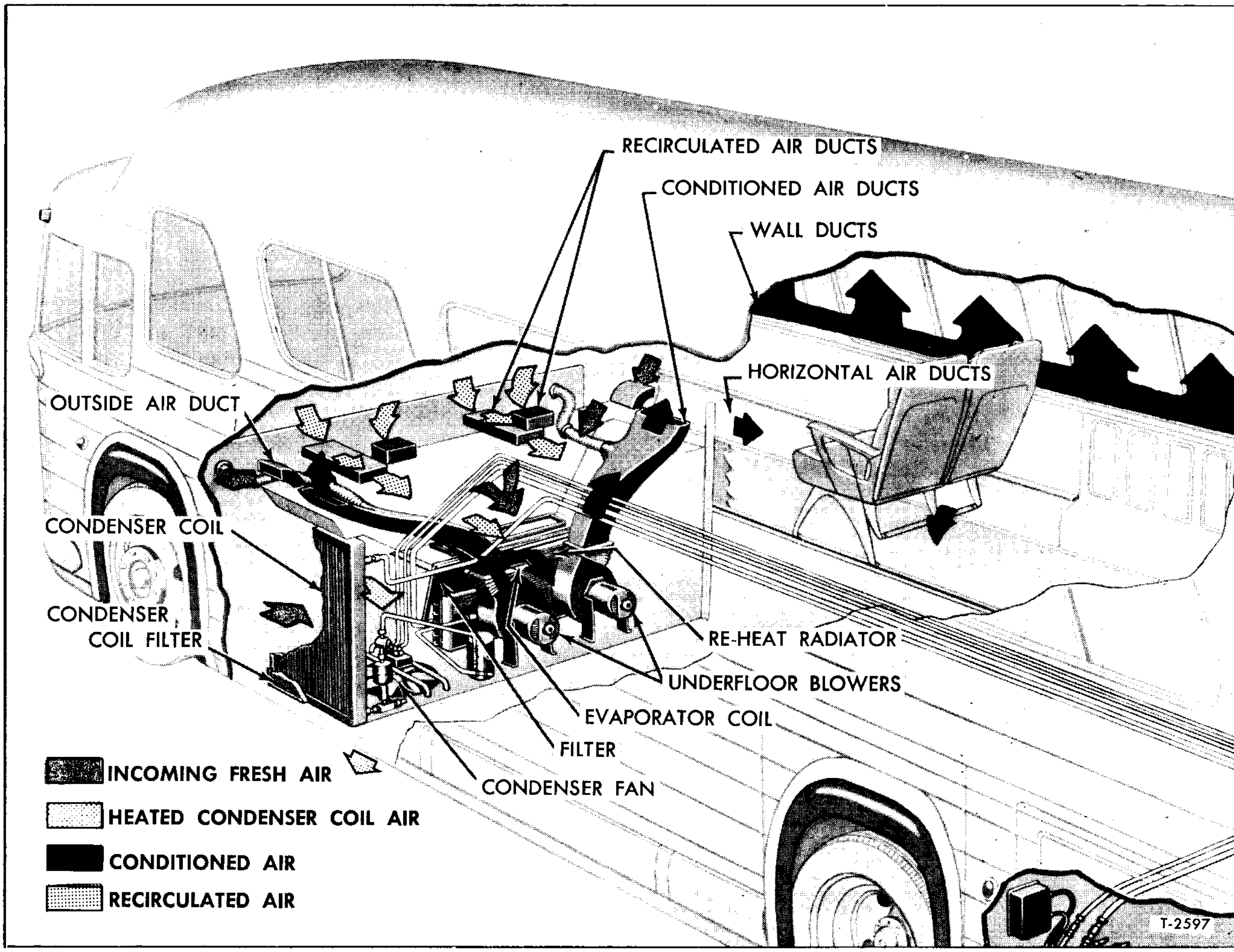

Figure 2—Air Circulation in Coach Body

the flow of water through system, and the operation of these controls is explained later.

Hot water is supplied by the engine cooling system to a large heater core which is located in the underfloor heating and air conditioning compartment (fig. 1). This compartment also encloses the air filter screen, air conditioning evaporator, and the air circulating blower assemblies. The water booster circulating pump assembly (fig. 5) is located in the outer right portion of this same compartment.

The control unit for controlling coach temperature is located in the right recirculating air duct, underneath passenger seat. Control rheostat (fig. 8) for selecting desired temperatures within a 12 degree range (68°F to 80°F) is mounted on control panel at left of driver.

The coach heating system is used as a reheat system when the air conditioning system is operated. Reheat of cooled air is automatically furnished whenever the air conditioning system pulls the coach temperature down below the control unit setting. Thus, whenever air conditioning capacity exceeds the cooling requirement, such excess capacity is used to de-humidify the air. The coach temperature remains at the set level by action of the control unit which controls heat admission to the heater core.

Defroster heater, located behind dash center closure panel, includes a heater core, two blowers, a dampered outlet for warming driver's feet, and a manually adjusted heater water flow control valve.

With defroster blowers operating, interior air is deflected over windshield, driver's window, and entrance door window. Warm air from the defroster heater compartment can be directed into driver's compartment by means of damper at left side of defroster compartment. Defroster heater motors can be operated at either high or low speed by switch marked "DEFROST", "HI", or "LO" on right side of instrument panel.

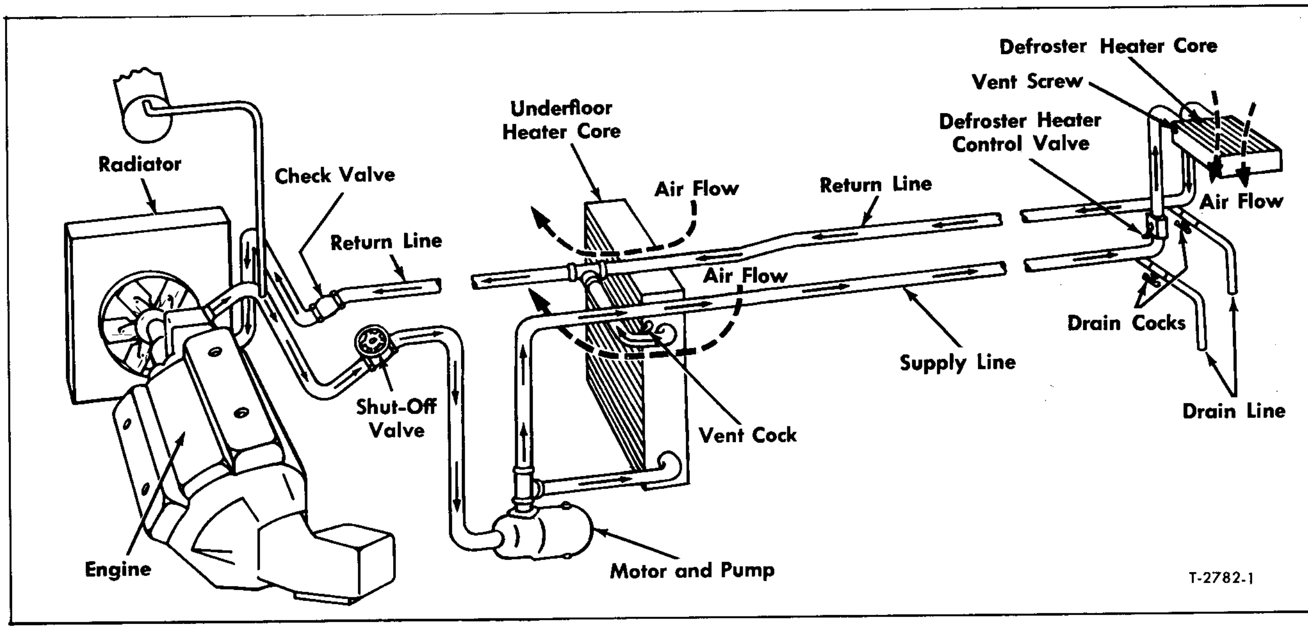

Figure 3—Heating System Water Flow

WATER CIRCULATION

(Refer to Figure 3)

Hot water from the engine cooling system is pumped through supply line to heater core by the water booster pump. After circulating through heater core, water flows through the return line back to engine. Warm water from the water pump outlet is also routed through a supply line to the defroster heater core at front of coach. Flow of water through the defroster heater core is controlled manually by control valve at right of driver. After circulating through heater core, water flows through the return line back to engine. A gate valve in heater supply line provides a means of isolating the heating system from the engine cooling system. This condition could occur in event one system needs to be drained without having to disturb the other. This valve is located on the upper center engine compartment bulkhead.

The water pump (fig. 5) is energized to circulate water through the heating system when the following occurs:

1. When temperature control unit calls for heat while the coach engine is running, with "HEAT-AIR COND" switch in any position other than "OFF".
2. When the lever of switch installed in the radiator surge tank filler compartment is held upward in the "WATER PUMP" position while the engine is running.

NOTE: This latter control serves to circulate coolant through the heating system when the system is being filled or replenished.

AIR CIRCULATION

(Refer to Figure 2)

The air circulation for interior heating and air conditioning is the same for both systems. With the "HEAT-AIR COND" switch in any position other than "OFF", the underfloor blower motors run continuously when the engine is running.

Blowers draw outside air into heating and air conditioning compartment through two perforated openings, one at each side of coach just below windows. Recirculated air is also drawn into compartment through two grille-covered recirculating air ducts, located under seats, one at each side of aisle, and through riser of second aisle step.

The blended air is then drawn by the blowers through the filter, evaporating coil, and heater core and forced into coach interior. With "HEAT-AIR COND" switch in "AIR COND" position, the blended air is cooled and dehumidified as it passes through the evaporating coil. As this conditioned air passes through the heater core it is heated to the selected temperature. With "HEAT-AIR COND" switch in "HEAT" position, the blended air is not effected by evaporator coil, but is heated to selected temperature as it passes through the heater core. Tempered air is forced into coach through longitudinal ducts along each side of coach at floor and up vertical ducts below side windows. Air outlets (fig. 4) in longitudinal ducts distribute conditioned air over floor and feet of passengers. Air to left side of driver's seat is admitted into area from longitudinal side duct

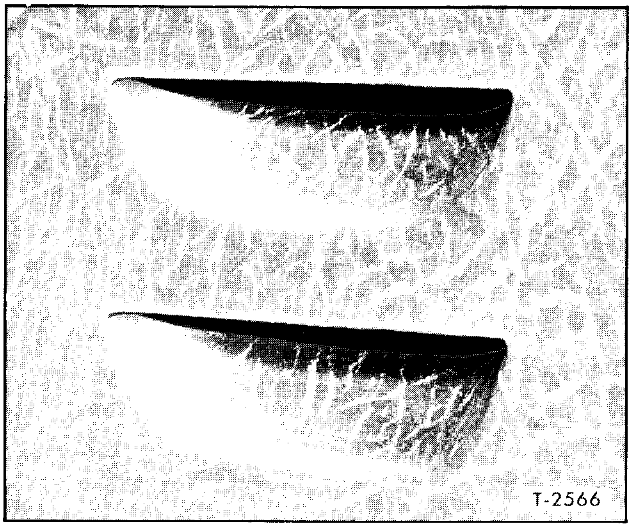

Figure 4—Underseat Air Outlet

through adjustable outlet.

NOTE: Both the underfloor blowers and defroster blowers tend to pressurize coach, thus forcing some air to exhaust constantly through louvered openings in entrance door.

HEATING SYSTEM CONTROLS

The various control units are as follows:

Water Booster Pump - Single electric motor driven pump is installed in heater supply line (fig. 5). Pump serves to circulate coolant through the heating and defrosting system when heat is in demand.

Defroster - Heater Temperature Control Valve - A manually controlled ball type valve is installed in the defroster heater core supply line (fig. 22). The valve handle, which extends through the heater compartment bulkhead at the right of driver, is manually adjusted to control the flow of water through heater core. Turn handle clockwise to open valve, counterclockwise to close.

Heater Line Shut-off Valve - A gate-type water valve (fig. 6), installed in supply line, is accessible through engine compartment and located on upper center of bulkhead. Closing the valve will prevent heating system from functioning.

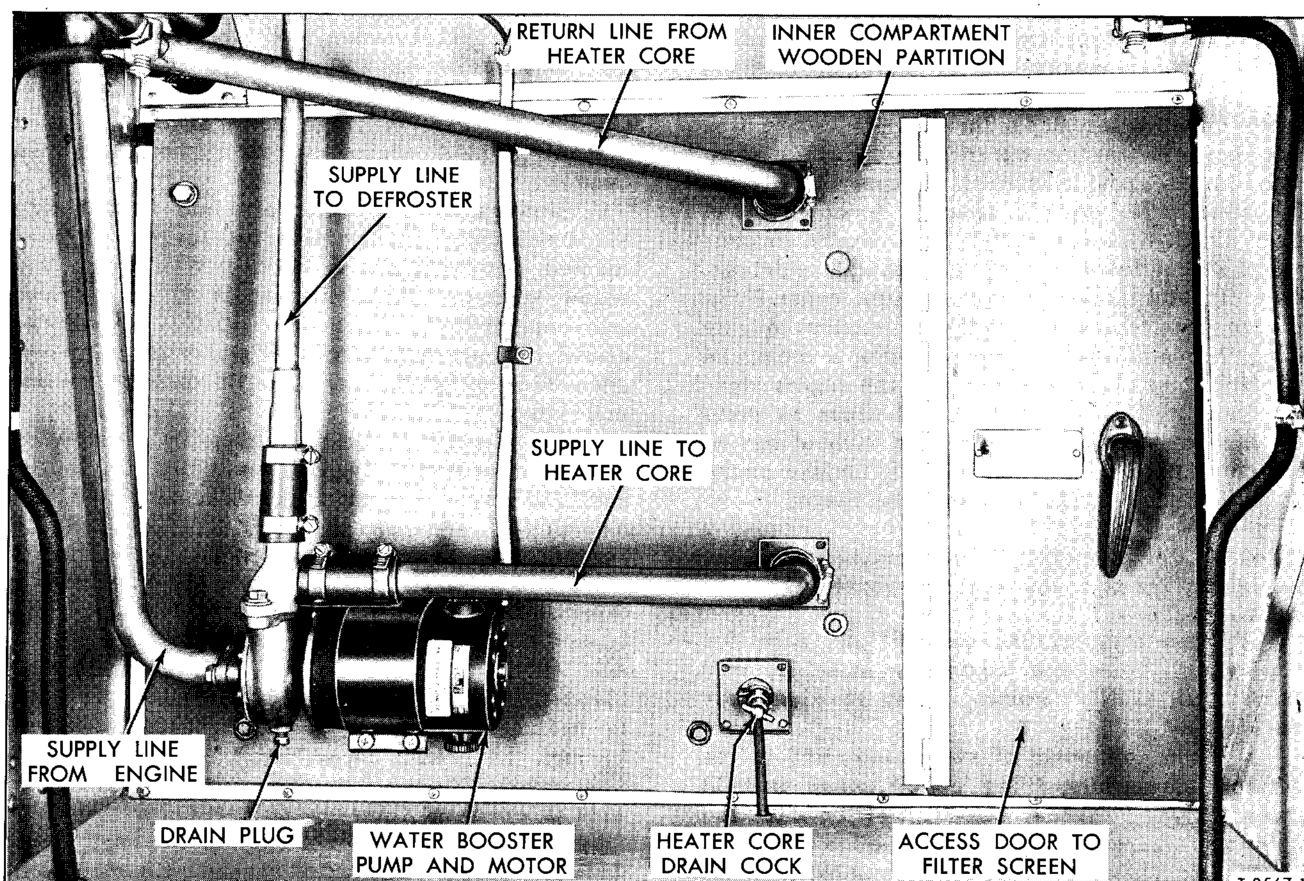

Figure 5—Water Booster Pump, and Water Supply and Return Lines

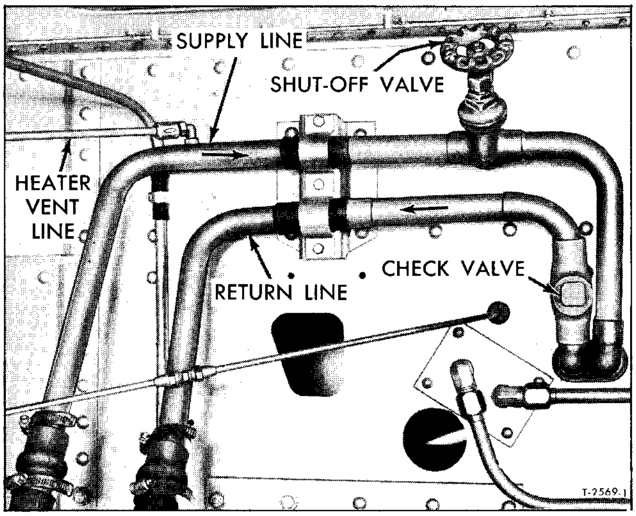

Figure 6—Heating System Water Shut-Off Valve

Use of valve is required to isolate engine cooling system from heating system in event either is to be drained without affecting the other.

Temperature Control Unit - An automatic sensing unit located in the right side recirculation duct (fig. 7). This unit controls the amount of voltage applied to water booster pump motor, thus controlling speed of pump which will in turn vary the flow of hot water through heating system.

Temperature Control - A temperature range control (fig. 8), mounted on panel at left of driver, can be adjusted to select the desired temperature for interior of coach.

CAUTION

Under no circumstances must heating or air conditioning systems be operated when the heating system has been drained; SERIOUS DAMAGE TO THE HEATING SYSTEM WATER BOOSTER PUMP SEAL WILL OCCUR.

In an emergency, where it is necessary to operate system dry, the electrical wiring at water pump should be disconnected. Tape wiring terminals.

MAINTENANCE

GENERAL

1. Heating system and engine cooling system should be flushed semi-annually as described in "COOLING SYSTEM - GENERAL" (SEC. 6).
2. At regular intervals, examine heater pipe joints and fittings, and heater core for leakage and make the necessary repairs. Clean all dirt from heater core.
3. Check for proper operation of heater motor, switches, and water booster pump at beginning of each heating season.

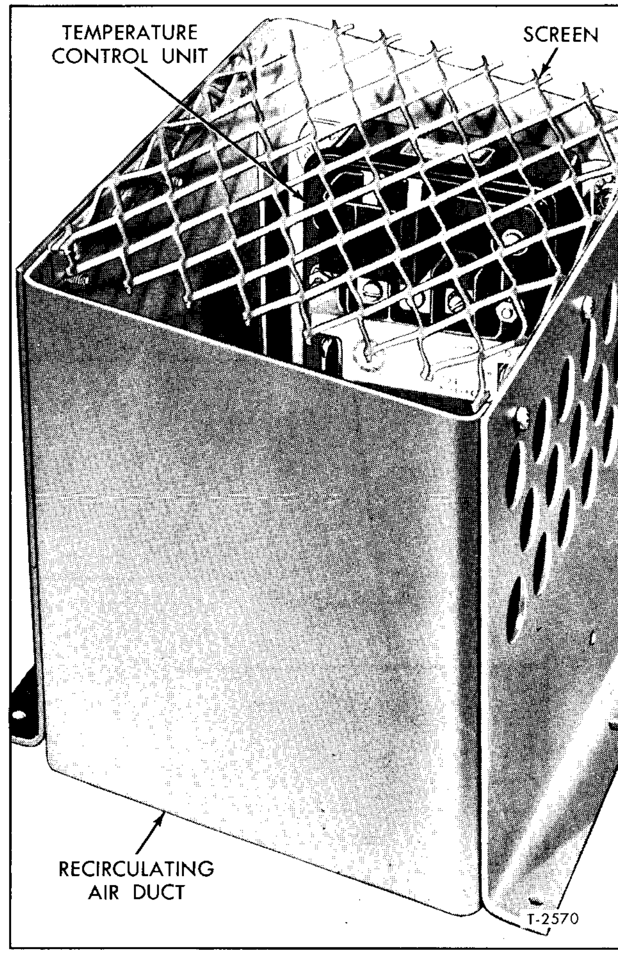

Figure 7—Recirculating Air Duct and Temperature Control Unit

4. Possible causes of improper heating are explained at end of this section under "Heating System Trouble Shooting Guide."

DRAINING SYSTEM

1. If heating system is to be drained without draining the engine cooling system, close the gate

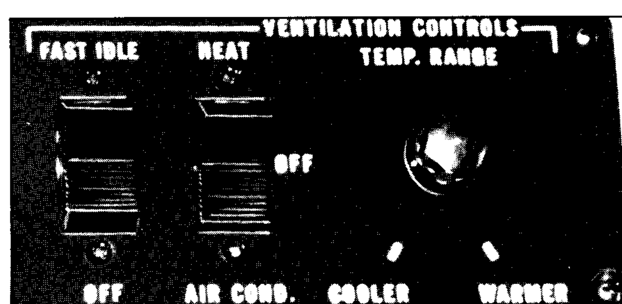

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Figure 8—Ventilation Controls

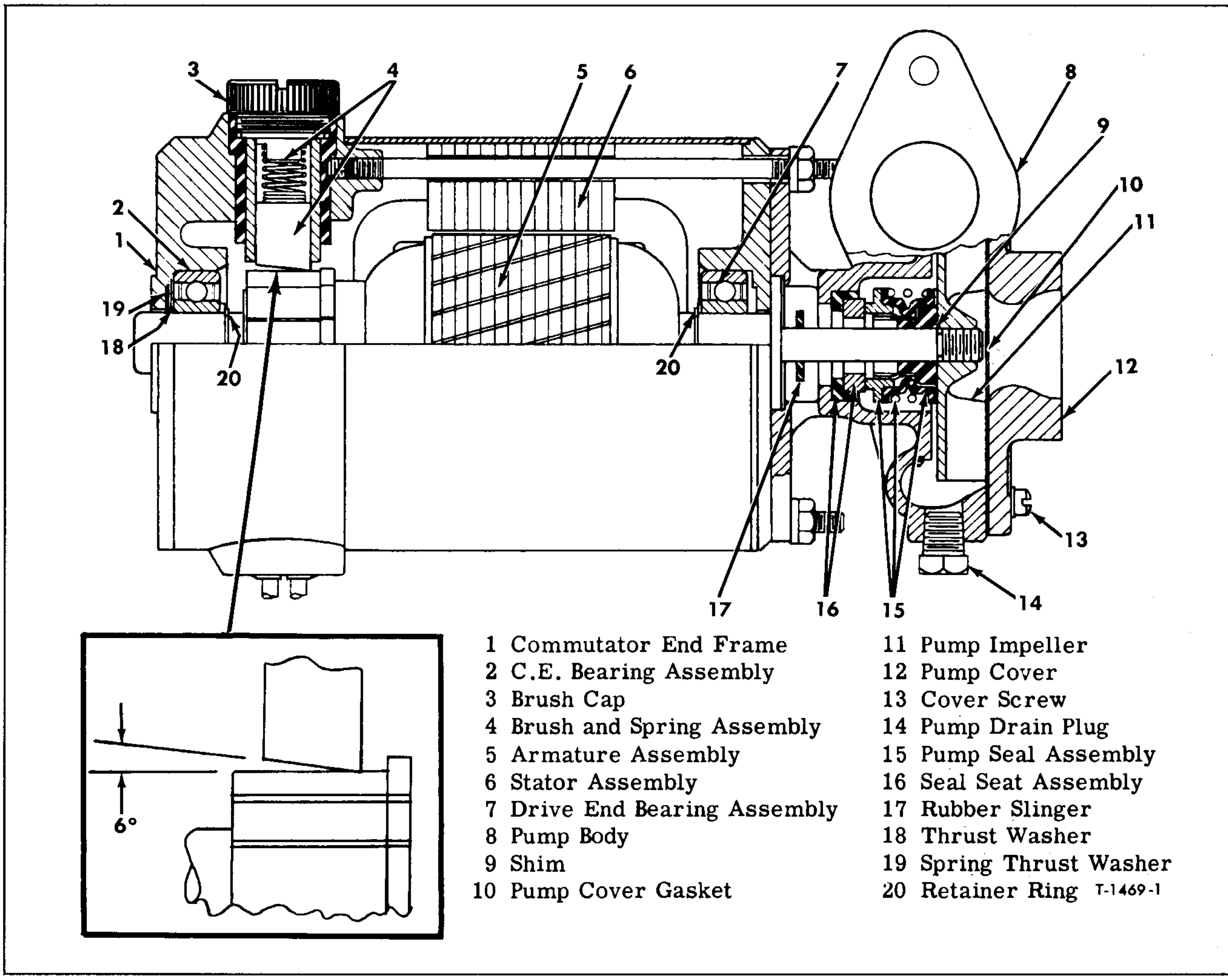


Figure 9—Water Booster Pump and Motor

valve (fig. 6) in the supply line. The gate valve is located on the upper center of the engine compartment bulkhead.

2. Open drain cock at right lower corner of underfloor heater core. Drain cock is accessible through compartment closure door.

3. Open two drain cocks in the defroster heater water lines located in compartment below heater core, accessible after opening dash compartment door and reaching down into compartment.

4. Rotate lever of defroster heater control valve fully clockwise to full-open position (fig. 22).

5. Remove drain plug from bottom of water booster pump.

FILLING

1. Make certain all drains and vent cocks are closed, that heater line gate valve is open, and that the defroster heater core temperature control valve is in full open position.

2. Fill heating system in same manner as explained in COOLING (SEC. 6) for engine cooling system.

3. With engine running, operate heating system water booster pump, using switch in surge tank filler compartment.

BLEEDING SYSTEM

IMPORTANT: Whenever engine cooling system or the heating system have been drained and then refilled, when system has run low and water is replenished, or whenever sufficient air has accumulated in system to retard normal flow of water, heating system should be bled to expel air.

1. Before bleeding, make sure all drains and vent cocks are closed, that heater line gate valve is open, and that the defroster heater control valve is open (fully clockwise).

2. As assistant operates the water booster pump, using switch in surge tank compartment, open vent screw at upper left corner of defroster

heater core (fig. 22), then close vent when water alone starts to flow.

3. Replenish engine cooling system.

HEATING SYSTEM WATER BOOSTER PUMP

Heating system water booster pump is mounted in the underfloor heating outer compartment (fig. 5). Pump operation is explained previously under "Water Circulation." Pump motor circuit is shown on "Heating and Air Conditioning Wiring Diagram" in back of manual.

Motor brushes can be replaced without removing pump and motor from mounting. For all other servicing, remove pump with motor as an assembly. Disassembly of pump is necessary only in case of a seal leak, motor bearing failure, or motor failure.

REMOVAL (Refer to Fig. 5)

1. Drain heating system.
2. Disconnect electrical wiring at motor.
3. Disconnect water lines at flange or hose connections.
4. Remove bolts which attach motor clamp strap to motor mounting bracket. Remove pump with attached motor.

DISASSEMBLY

(Key numbers in text refer to figure 9.)

1. Remove two brush caps (3) and two brush and spring assemblies.
2. Remove pump cover (12) by removing eight fillister head screws. Remove cover carefully to prevent damage to gasket (10).
3. Remove gasket (10).
4. Remove pump from motor as follows:

a. Remove impeller (11). Impeller is threaded onto shaft. Prevent shaft from rotating by inserting screw driver in slot provided at opposite end of shaft.

b. Remove shims (9). Note number of shims.

c. Remove seal spring and washer from shaft by lifting gently. Seal seat will remain in pump body.

d. Remove two hex nuts and lock washers which attach pump body (8) to motor.

5. Remove the floating seal seat (16) from the pump body by gently pressing from the motor side of the body.

CAUTION: Do not scratch or mar the sealing surface of this seat.

INSPECTION (Refer to Fig. 9)

Compare components with new parts to determine degree of wear.

Brushes

1. When removing brushes, note the position of the brush in the tube. Brush life is shortened if brushes are not replaced properly.
2. Brushes should be examined for:

a. Wear. Replace if less than 25% of the usable brush is left (less than .300 of an inch).

b. Chipped Edges. Chips can be caused by improper handling or installation. Badly chipped brushes should be replaced regardless of length.

c. Annealed Brush Spring. Annealing can be detected by noting the resiliency of the spring. Annealing is caused by failing to tighten brush caps properly, thus not providing a good low resistance contact between the terminal and brush tube. Brushes evidencing annealed springs should be replaced.

d. Frayed or Broken Pigtail. An improperly installed brush may have the pigtail (shunt) pinched under the terminal or between the coils of the spring.

3. When replacing brushes the following items are important:

a. The face of a new brush is carefully cut to cause proper seating during the "wear-in" period.

b. Improper installation can harm both the brush and the commutator.

c. Replacement brushes should be of the proper grade.

d. New brushes have a 6° angle on the brush face. The brush should always be inserted so the angle is open away from the pump end of the assembly (see fig. 9).

e. Brush performance is degraded if the spring and terminal are not properly placed in the tube. The spring should be free over its entire length and the terminal should make good contact with the metal brush tube insert.

Bearings

1. Rotate motor shaft. If ball bearings show evidence of wear, they should be replaced.
2. When removing armature from motor, the number of washers and their arrangement should be noted. Improper number or installation of washers can cause improper tracking of brushes, excessive preloading of bearings, and noisy operation.
3. The use of bearing puller tool is recommended when removing bearings, to prevent damage to the armature winding or commutator.
4. Replacement bearings should be pressed to the same exact location as the original installation.
5. The use of a suitable sealant (such as Loctite or equivalent) is recommended between the shaft and bearing if the fit does not seem tight enough to prevent the shaft from spinning inside the inner race.
6. After replacing bearings, the position of the commutator in the motor can be checked by

looking down the brush tube. Neither the riser nor the edge of the commutator should be visible.

Commutator

1. The commutator is a precise assembly. Although solidly built of fairly tough material, it is easily ruined by careless handling.

2. Refinishing should be done only on equipment which will provide good concentricity and the proper finish.

3. Refinishing should be done if a micrometer reading shows a difference between "in track" and "off track" diameter of .187" or more.

4. The commutator should be carefully undercut with a .025" or less slot width.

5. A 25 to 50 microinch finish is desirable on a new or refinished commutator.

6. Commutator should not be touched with the fingers, as sweat and body oils rapidly discolor and oxidize the surface.

Miscellaneous

1. Check the rubber shaft slinger (17) to make sure it is tight on the motor shaft. If it slips on the shaft it should be replaced.

2. Inspect the seal and seat assemblies (15 and 16) to determine wear. If the seal has leaked, or is badly worn, installation of a complete new assembly is recommended. However, in an emergency, or if a completely new seal assembly is not at once available, a new component may be installed to replace the damaged member. This procedure should be followed only when a complete new seal assembly is not available.

ASSEMBLY (Refer to Fig. 9)

1. Install floating seal seat (16) in the pump body (8) in the following manner:

a. Clean seat in gasoline or some cleaning solvent to remove any dust or dirt.

b. Insert the seat in the proper recess in the pump body. This is a snug fit, but a drop of machine oil or a small amount of clean grease applied only to the neoprene ring and to the body cavity will insure easy installation. Be sure the seat bottoms in the pump body around its entire circumference.

2. Install slinger (17) on motor shaft.

3. Assemble body (8) to motor.

4. Lubricate pump shaft with a small amount of light oil, then slip seal bellows and washer assembly (15) onto shaft so that the seal washer contacts the seal seat (16) in the pump body (8).

5. Install impeller (11) in following manner:

a. Place impeller shims (9) on motor shaft.

b. Screw impeller onto shaft until it bottoms on shims and shoulder of shaft. Prevent shaft rotation by inserting screw driver in slot provided at end of motor shaft. Tighten impeller securely. With proper number of shims, face of impeller blades should be flush with, or within 0.005", of machined face of pump body; add or delete shims (9) as required.

6. Install gasket (10). This gasket is 0.010" thick and serves both to seal the cover and to establish proper clearance between the face of the impeller and the pump cover.

7. Attach cover (12) to pump body using eight fillister head screws (13).

8. Install motor brushes (4) and brush caps (3), observing the precautions mentioned previously in item 3 under "Inspection."

INSTALLATION OF PUMP AND MOTOR (Fig. 5)

1. Apply gasket cement to pump body line adapters and to line flanges (if flanges were separated). Place pump and motor assembly in position to mounting bracket and secure with clamp.

2. Reconnect line adapter to pump using new gaskets. Make sure connections are tight. If pipes were not separated from pump body, engage hose connections. Tighten clamps firmly.

3. Connect electrical wiring.

4. Fill heating system as previously instructed under "Filling."

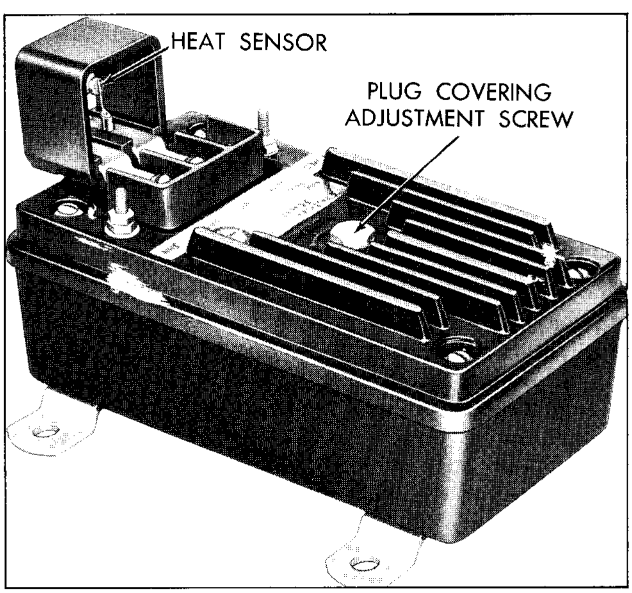


Figure 10—Temperature Control Unit

TEMPERATURE CONTROL UNIT

The temperature control unit (fig. 10) automatically maintains a constant temperature within the coach. This unit controls the amount of voltage applied to water booster pump, varying the speed, thus controlling the flow of hot water through the heating system.

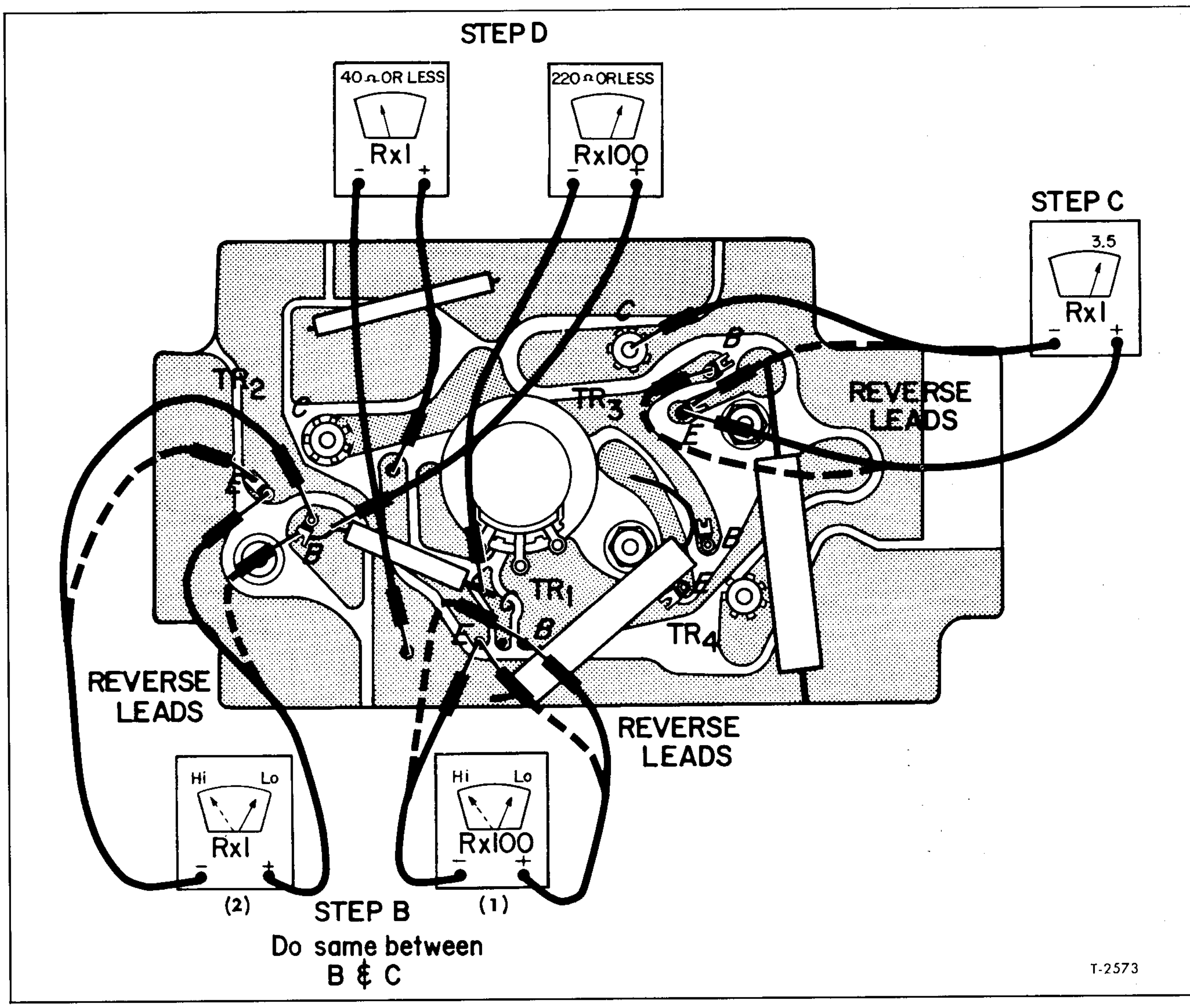


Figure 11—Test Set-Up When Pump Motor Will Not Shut-Off

The component which controls the unit is the sensor or heat sensitive resistor. This sensor changes value with changes in temperature, and thus controls the operation of the transistors in the unit. The transistor in turn controls the amount of voltage applied to the water booster pump motor, which determines the speed of the pump. As the speed of the motor varies, the flow of hot water through the heating system varies, thus controlling the amount of heat delivered.

There are two adjustments necessary to attain the desired temperature. The coarse adjustment, which determines a broad range, is pre-adjusted at the factory. This is normally set for a range of 68°F to 80°F, and will turn from full off to full on with a maximum coach temperature change of 2°F from selected temperature. An external control, the temperature range control (fig. 8), mounted on control panel to left of driver, will select any temperature within the pre-adjusted range set by the coarse adjustment (68°F to 80°F).

Circuit through control unit is shown on "Heating and Air Conditioning Wiring Diagram" in back of this manual.

MAINTENANCE

If the temperature range control can not be adjusted to obtain the desired temperature, then the coarse adjustment will have to be adjusted. Adjust the coarse control as follows, referring to figure 10.

1. Remove plug covering adjustment screw.
2. Turn screw clockwise to raise temperature range, counter-clockwise to lower it.
3. Replace plug.

If this adjustment has no effect, refer to the "Trouble Shooting" procedures which follow.

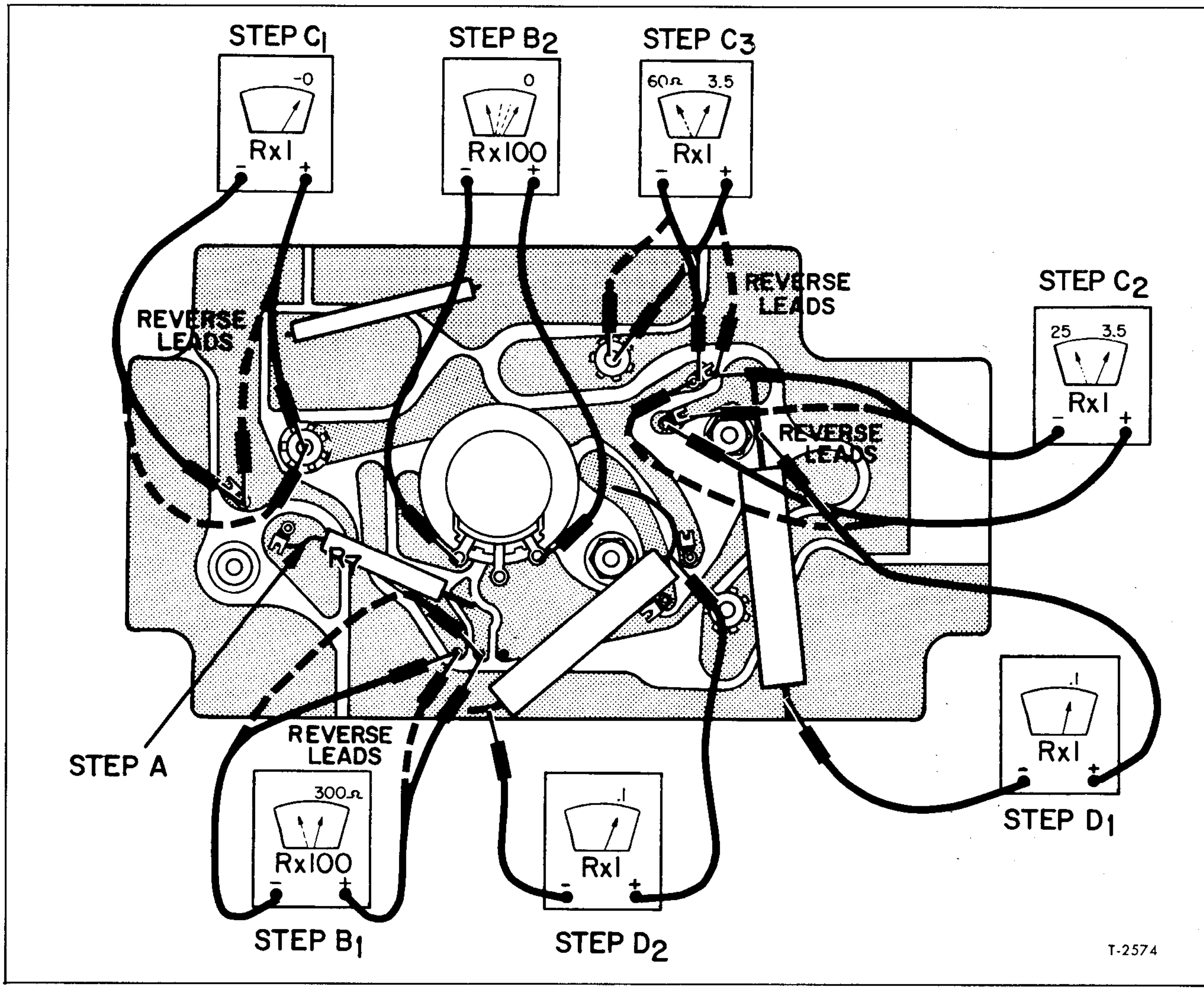


Figure 12—Test Set-Up When Pump Motor Will Not Start

TROUBLE SHOOTING

Failure within the unit can be placed in two general categories; motor will not shut off or motor will not start.

Pump Motor Will Not Shut Off

a. Remove sensor (figure 10) and check with ohmmeter on RX100 scale of meter. The meter should show between 1K and 5K at normal temperatures. Holding the sensor between the fingers should cause the resistance to decrease. If the sensor is open, the meter will read much higher.

b. If sensor is satisfactory, reinstall it and remove top cover of control. The next possible defect could be a transistor, either TR1 or TR2, which has opened.

(1) To check TR1, use an ohmmeter as in figure 11, step B2, to measure the resistance between E and B. First put the positive lead on B and the negative on E; the ohmmeter should indicate less than 800 ohms. Reverse leads; the ohmmeter should indicate a reading of at least five times the first indication. Repeat this check between C and B of TR1. The readings should fall within the same limits as indicated between E and B. If these indications are not attained, TR1 is open and should be replaced.

(2) To check TR2, use an ohmmeter set on RX1 scale as in Figure 11, step B1, to measure the resistance between E and B. First put the positive lead on B and the negative lead on E. The ohmmeter should indicate 10 ohms or less. Reverse leads; the indication on meter should be at least 10 times more. If these indications are not attained, TR2 is open and should be replaced.

c. If either TR3 or TR4 is shorted, they will cause motor to run continuously. To check this, connect an ohmmeter set on RX1 scale between C and C of TR3 as shown in figure 11, step c. Note reading. Reverse leads and note reading;

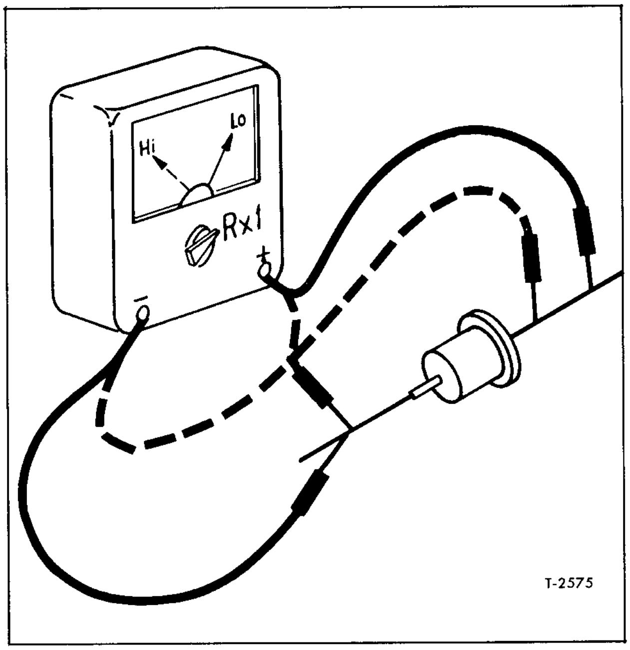


Figure 13—Testing Diode D1

both should indicate above 3 ohms. If either one was zero, then TR3 or TR4 or both are shorted and should be replaced.

TR3 and TR4 are a matched pair, so both must be replaced at the same time.

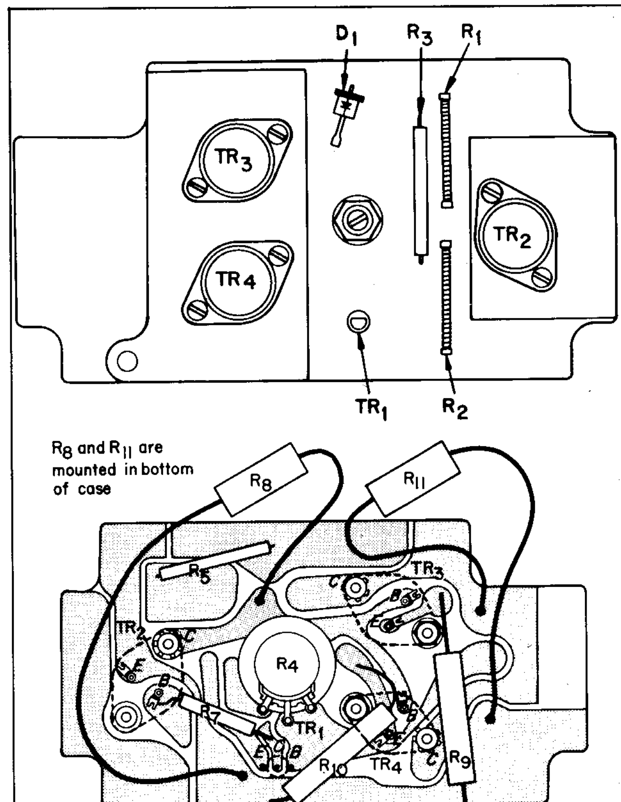
d. If either R2 or R7 is open, this could also cause the motor to run constantly. To check this, measure as shown in figure 11, step d. With ohmmeter scale set on RX1, measure resistance of R2; ohmmeter should indicate slightly less than 40 ohms. With ohmmeter scale set at RX100, measure resistance of R7; ohmmeter should indicate slightly less than 220 ohms. If resistance of R2 or R7 should be appreciatively less than value called for, replace as necessary.

Motor Will Not Start

a. To isolate this problem to one section of the control, unsolder and lift one end of R7 as shown in figure 12, step a. If the motor starts running full speed, go to step b. If the motor still does not start, go to step c.

b. (1) Connect the ohmmeter to TR1 as shown in figure 12, step b 1. Then reverse the leads and measure again. Neither reading should be below 300 ohms. If either reading is zero, the transistor is shorted and should be replaced.

(2) Connect the ohmmeter as shown in figure 12, step b 2. Mark the position of the screw slot of the potentiometer on the case. Then rotate the screw to both extremes of travel with the ohmmeter still connected. If the ohmmeter reading changes as the screw is turned, return the screw to its original position. If the ohmmeter does not move, replace the potentiometer.



Unit	Part No.	Description
TR_1	DS46	Pre-Amp
TR_2	DS503	Amplifier
TR_3 & TR_4	Output Transistors (Matched Pair)	
D1	Diode	
R1	40 Ohm 3W	
R2	40 Ohm 3W	
R3	2.3K 3W	
R4	Coarse Adjustment Potentiometer	
R5	2.3K 3W	
R6	Sensor	
R7	220 Ohm 3W	
R8	10 Ohm 40W	
R9	.1 Ohm 10W	
R10	.1 Ohm 10W	
R11	5 Ohm 50W	

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Figure 14—Component Placement on Printed Circuit Board

c. (1) Connect the ohmmeter as shown in figure 12, step c 1, and read the resistance. Then reverse the leads and read again. Both readings should be above 3 ohms. If either reading is zero, replace the transistor TR2. If readings are as required, proceed to next step.

(2) Connect the ohmmeter as shown in figure 12, step c 2, and read resistance; then reverse the leads and read again. The first reading should be under 5 ohms and the second 25 ohms or above.

(3) Connect the ohmmeter between C and B as

in figure 12, step c 3, then reverse the leads. These two readings should fall in the same ranges as in step 2. If the first reading of either step 2 or 3 is higher than 5 ohms, remove and replace both TR3 and TR4 because they are a matched pair.

d. (1) Connect the ohmmeter as shown in figure 12, step d 1. It should read 0.1 ohm. If it is higher, replace R9.

(2) Repeat for R10 as in step d 2 of figure 12. It also should read 0.1 ohm.

NOTE: If the system repeatedly breaks down with the same type of failure, check diode D1 and resistor R11. These are protection devices and if these do not function properly, the transistors or other parts of the circuit can become damaged as the system turns on and shuts off.

e. To check diode D1, remove it from the circuit and measure resistance as shown in figure 13. Reverse leads and measure again. The low reading should be approximately 10 ohms and the high reading at least 5 times the low. If the readings are not right, replace the diode.

g. Resistor R11 can be measured in the circuit and should read approximately 5 ohms. Refer to figure 14 for the position of R11.

UNDERFLOOR HEATING AND COOLING COMPARTMENT

Underfloor heating and air conditioning compartment is located under coach floor at rear of fuel tank compartment (fig. 1). Access to compartment is obtained through right forward evaporator compartment door and through wooden inner compartment partition and door. Inner door is hinged to partition which is attached to opening with screws and washers.

Compartment is air tight, made so by use of seals at door and at wiring and lines entering compartment. Water drains and traps in floor under forward area of compartment allows moisture collected on air conditioning evaporator to drain from compartment, and are so designed to eliminate air from entering compartment. Compartment unit consists of an air filter screen, air conditioning evaporator, heater core and blower units.

EVAPORATOR-HEATING UNIT ASSEMBLY

REMOVAL

1. Drain heating system as previously explained under "Maintenance."
2. Disconnect heater supply and return pipe connection at core by removing hose clamps (fig. 5).
3. Disconnect heater supply and return pipe connections at inlet and outlet to compartment by removing hose clamps (fig. 4).
4. Remove five hex bolts attaching wooden interior compartment partition, then remove partition (fig. 7).
5. Pump down the refrigerant system as explained under "Pumping Down the System" in the "AIR CONDITIONING SYSTEM" section. Unsolder refrigerant lines at heat exchanger in condenser compartment (fig. 13 in "AIR CONDITIONING SYSTEM" section).
6. Remove bolts, washers, and nuts attaching flexible ducts to blower housings. Loosen clamps securing drain hoses to floor brackets, remove hoses (fig. 1).
7. From underneath coach, remove six hex bolts which attach evaporator-heating unit to compartment floor.
8. Unscrew hose, clamp, and nipple assemblies from flanges (fig. 1) at top of compartment between heater core and blower.
9. Carefully pull evaporator-heating unit from compartment.

INSTALLATION

1. Slide evaporator-heating unit into compartment. Make sure guide at top of evaporator coil is in guide rail, also that mounting holes are aligned properly.
2. Secure evaporator-heating unit to compartment floor with six hex head bolts from underside of coach.
3. Screw hose, clamp, and nipple assemblies into flanges at top of compartment. Insert drain hoses into clamps on floor brackets and tighten clamps. Attach flexible ducts to blower housing.
4. Solder refrigerant lines to heat exchanger inlet and outlet. NOTE: Clean surfaces to be soldered using No. 00 steel wool, then apply thin coat of "Nokorode" flux. Sweat connection with special 95% tin and 5% antimony solder.
5. Install and secure wooden partition to evaporator-heating unit.
6. Connect all hoses and clamps to compartment hot water supply and return connections, and to heater core inlet and outlets.
7. Fill heating system as previously described under "Maintenance".
8. Charge refrigerant lines as described under "Charging the System" in the "AIR CONDITIONING SYSTEM" section.

UNDERFLOOR AIR FILTER SCREEN

Air filter screen, mounted at forward end of heating and cooling compartment (fig. 1), filters all air passing through compartment and is accessible after opening forward compartment door and inner wooden door. Filter is easily removed from compartment by pulling from slide channels.

A clogged filter screen restricts air circulation, thus reducing efficiency of system. In addition to the effect on system operation, a dirty filter will permit dirt to pass into evaporator coils and heater core, clogging coils and fins.

AIR FILTER SCREEN MUST BE KEPT CLEAN FOR SATISFACTORY OPERATION OF HEATING AND AIR CONDITIONING SYSTEMS

Air filter screen is of all metal construction and should be removed frequently and thoroughly washed. Filter screen should then be sprayed sparingly with odorless oil, or dipped and thoroughly drained. Install air filter screen in slide channels with coarse screened surface of filter (if one side is coarser than other) facing front of coach. THE IMPORTANCE OF CLEANING OR CHANGING THE AIR FILTER AT FREQUENT INTERVALS SHOULD BE IMPRESSED UPON ALL MAINTENANCE PERSONNEL.

Refer to "System Maintenance" section in "AIR CONDITIONING" later in this group for removal and installation procedures.

HEATER CORE

The heater core (fig. 1), located between the blowers and evaporator, is of fin and tube design, similar to a conventional radiator core. Heater core can be repaired in same manner as a conventional radiator core.

REMOVAL OF HEATER CORE

1. Remove evaporator-heating unit as previously described.
2. Remove nuts and bolts securing heater core to evaporator-heater unit frame, then remove heater core.

INSTALLATION OF HEATER CORE

1. Position heater core in evaporator-heater unit frame.
2. Install gasket between heater core and evaporator coils at both side ends.
3. Secure heater core to evaporator-heater unit frame with nuts and bolts.
4. Install evaporator-heater unit into compartment as previously described.

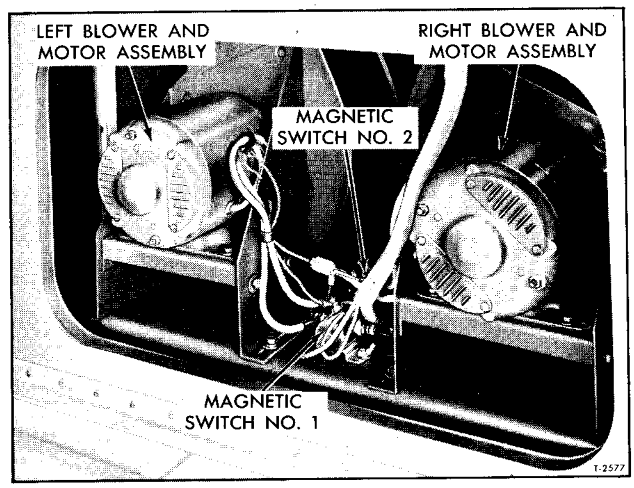


Figure 15—Underfloor Blower and Motor Units Installed

UNDERFLOOR BLOWER AND MOTOR UNIT

(Refer to Figure 15)

Underfloor blower and motor units consist of the motors, blowers, and blower housing.

Complete units are accessible through forward baggage compartment after removal of plate from bulkhead. The entire unit, supported on mounting brackets and secured in position by four bolts each, can be removed from compartment as explained under "Blower and Motor Unit Replacement".

Blower motors operate whenever the engine is running and "HEAT-AIR COND" switch is in any position other than "OFF". Motor circuits are controlled by magnetic switches which are mounted on evaporator-heating unit between motor mounts (fig. 15). Servicing of magnetic switches is explained later under "Underfloor Blower Motor Magnetic Switches".

UNDERFLOOR BLOWER AND MOTOR UNIT REPLACEMENT

REMOVAL (Refer to figure 15)

1. Disconnect wires from magnetic switch.
2. Remove four screws and nuts securing underfloor ducts to blower housing.
3. Remove four capscrews and washers securing motor mounting to evaporator-heating unit frame.
4. Remove blower and motor unit from heating and air conditioning compartment through opening into baggage compartment.

INSTALLATION (Refer to figure 15)

1. Position blower and motor unit onto evaporator-heating unit frame and attach with

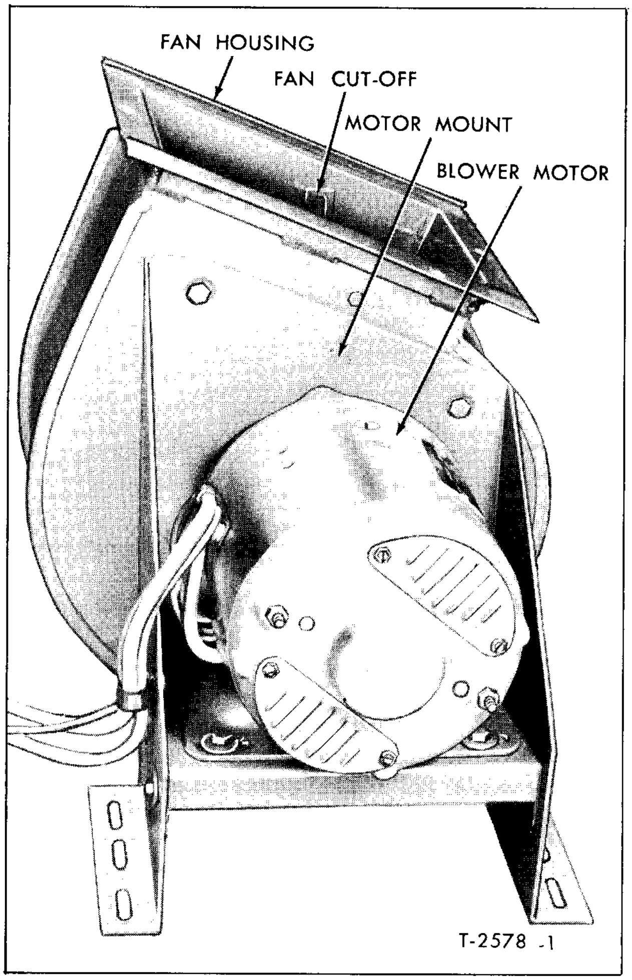


Figure 16—Underfloor Blower and Motor Unit Removed

four capscrews and washers.

2. Secure underfloor duct to blower housing with four screws and nuts.

3. Connect wires from motor to magnetic switch.

BLOWER AND MOTOR UNIT DISASSEMBLY

DISASSEMBLY (Refer to figure 16)

1. Remove blower and motor from heating and air conditioning compartment as previously instructed.

2. Loosen two screws securing fan wheel to blower motor shaft.

3. Remove four bolts, washers, and nuts attaching blower motor to mount, then remove motor.

4. If necessary to remove fan wheel, mark location of fan cut-off, then remove bolts, washers, and nuts securing fan cut-off. Remove cut-off and fan wheel.

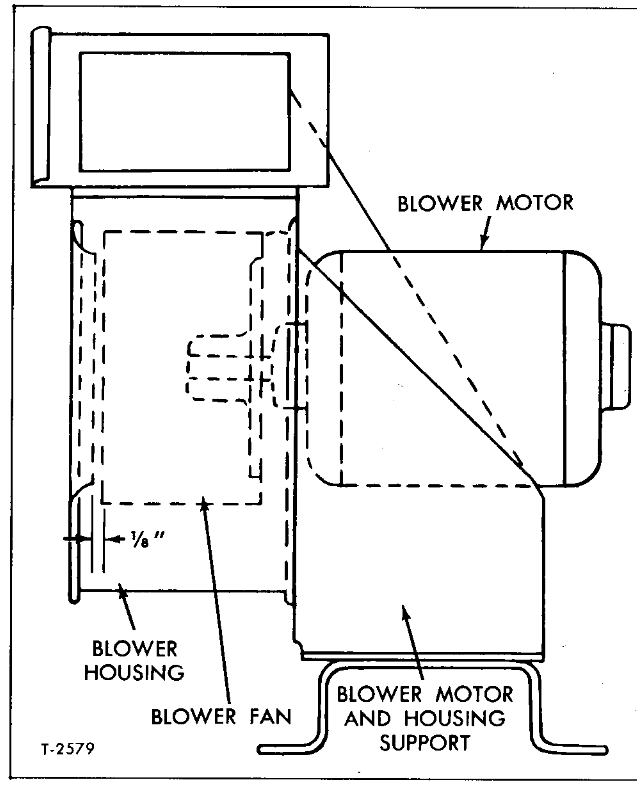


Figure 17—Blower Fan Adjustment

ASSEMBLY (Refer to figure 16)

1. If fan wheel was removed, install fan wheel into fan housing.

2. Position blower motor on motor mount and position fan wheel onto blower motor shaft. Secure blower motor to mount with four bolts, washers, and nuts.

3. Adjust fan wheel on blower motor shaft for clearance of 1/8 inch between fan wheel and housing venturi (fig. 17). Tighten set screws.

4. Install fan cut-off and secure with bolts, washers, and nuts. Make sure fan cut-off is located as marked prior to removal.

UNDERFLOOR BLOWER MOTOR REPAIR

BRUSHES

Motor brushes can be replaced without disassembling motor.

1. Brushes should be replaced if they measure less than 5/8 inch on the long side. If brushes are of sufficient length but are not seating on commutator properly, seat brushes, using a "bedding" stone. Do Not Use Emery Cloth or Sandpaper. With motor operating, press bedding stone firmly against area on commutator contacted by brushes. Brushes should seat satisfactorily in a short period. Blow motor out with low pressure compressed air to remove all particles

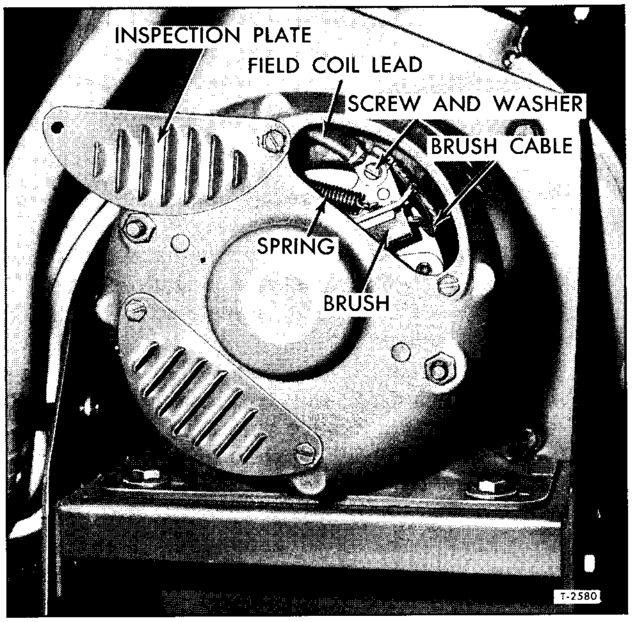
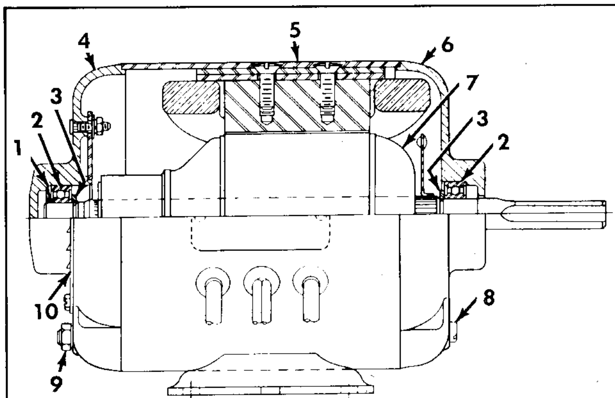


Figure 18—Removal and Installation of Motor Brushes



1 Spring Washer
2 Bearing
3 Spacer
4 End Frame and Brush Bracket Assembly
5 Frame and Coil Assy.
6 End Frame
7 Armature Assembly
8 Thru Bolt
9 Thru Bolt Nut
10 Inspection Plate

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Figure 19—Sectional View of Blower Motor

of abrasive after using stone, then check tightness of pigtail lead connections.

If, after the foregoing inspection operations, motor still fails to run, it will be necessary to disassemble motor to accomplish needed repairs.

2. To replace brushes, refer to figure 18.

a. Remove inspection plates from rear of motor.

b. Remove screws and washers which secure field coil and brush cable to bracket.

c. Detach spring retaining brush to bracket and remove brush.

d. Install new brush into bracket and attach spring to hook.

e. Attach field coil lead and brush cable to bracket with screw and washer.

f. Check brushes for proper seating. If brushes are not seating properly, refer to step 1 above.

g. Replace inspection plates and secure with screws.

DISASSEMBLY OF MOTOR

Key numbers in text refer to figure 19.

1. Remove brushes as previously instructed under "Brushes".

2. Remove two thru bolts nuts (9).

3. Tap end frame and brush bracket assembly (4) with soft hammer to loosen, then separate end frame and brush bracket assembly (4) from frame and coil assembly (5).

4. Pull armature and shaft assembly (7) out of frame and coil assembly (5). NOTE: Bearings (2) and spacer (3) will be intact on shaft. Remove spring washer(s) (1).

5. If necessary, shaft bearing (2) and spacer (3) can be readily removed from shaft, using a conventional bearing puller.

6. To separate end frame (6) from frame and coil assembly (5), remove two thru bolts (8).

PARTS INSPECTION AND TEST

Before proceeding with repair operations, the following inspections should be made:

1. Check armature to commutator leads to be sure they are properly soldered. Loose leads should be resoldered.

2. Inspect commutator and if found to be rough, out-of-round, worn, has high mica, or is badly burned, replace armature or repair commutator as instructed later under "Armature Repair."

3. Inspect field coil insulation. If insulation is cracked, charred, or worn so that wire is exposed, it is recommended that field coil and frame assembly be replaced.

4. Check length of brushes and replace if less than 5/8 inch long, measured on longest side. Be sure that leads are secure in the brushes and that terminals are properly fastened to leads.

5. Carefully inspect ball bearing assemblies for evidence of damage or wear. If rough, pitted, or worn, replace bearing assembly.

6. Inspect brush bracket assembly and brush retainer spring assembly for wear or damage. If either assembly is badly worn or broken, replace with new assembly.

TESTING ARMATURE

1. With a conventional test light and prods, test armature for ground. Place one test prod on

armature shaft and other on commutator. If test light lights, armature is grounded and should be replaced.

2. If armature is open circuited, this can easily be detected visually, since an open circuit in the armature usually results in badly burned commutator bars.

3. To test armature for short circuit, place armature on growler connected to alternating current. Hold hack saw blade over armature while armature is rotated slowly. If saw blade vibrates or buzzes, armature is short circuited and should be replaced. However, before replacing an armature that is apparently shorted, inspect commutator slots for copper or brush dust deposits, clean thoroughly, and re-test.

4. Test armature terminal circuits for continuity. Place one test prod on armature terminal and other on terminal of each wire. If test lamp fails to light, wire is open circuited and should be replaced.

ARMATURE REPAIR

1. To turn down commutator, center armature in lathe; then machine until rough or worn spots or out-of-round condition has been removed.

CAUTION: Do not machine more than necessary.

2. Mica between commutator segments must be below surface of segments. If this condition does not exist, undercut mica until it is 1/32" below surface of segments. After undercutting, use No. 00 sandpaper to clean and smooth up commutator, then use compressed air to remove all fine particles or cuttings.

3. If armature is open-circuited, burned commutator riser bars may result. When bars are not too badly burned, armature can sometimes be saved by rewelding the leads in the riser bars. After welding, turn down commutator and undercut mica as directed in steps 1 and 2.

ASSEMBLY OF MOTOR

Key numbers in text refer to figure 19. After all parts have been inspected and repaired or replaced, assemble blower motor as follows:

1. If bearings were removed, assemble spacers (3) and bearings (2) on armature shaft.

2. Position end frame (6) to frame and coil assembly (5), then insert thru bolts (8).

3. Apply a thin coating of grease around inside of bearing housing end frames.

4. Insert armature (7) with bearings (2) and spacers (3) through frame and coil assembly (5) and through end frame (6). Install spring washer (1) on armature shaft.

5. Position end frame and brush bracket assembly (4) to frame and coil assembly (5) and onto thru bolts (8). Secure with thru bolt nuts (9).

6. Replace carbon brushes as previously explained under "Brushes".

7. Connect motor to a 12 volt D.C. power source. Check rotation of armature. If armature rotation is opposite of rotation stamped on name plate, reverse armature leads to brushes.

8. Replace inspection plates (10) and secure with screws.

UNDERFLOOR BLOWER CONTROL MAGNETIC SWITCHES

Blower control magnetic switches, which control blower motors circuits, are mounted between motors in the heating and air conditioning compartment (fig. 15). These magnetic switches are used to control the speed of the blower motors. Electrical circuits and connections are shown on "Heating and Air Conditioning Wiring Diagram" in back of this manual.

With "HEAT-AIR COND." switch in "HEAT" position, magnetic switch No. 1 (fig. 15) is energized, activating circuit to blower motors (slow speed). With "HEAT-AIR COND." switch in "AIR COND." position, magnetic switches No. 1 and No. 2 (fig. 15) are energized, activating circuit to blower motors (high speed).

Switches are sealed units and are not adjustable or reparable. If either switch fails to function properly, the defective unit must be replaced.

DEFROSTER HEATER

Defroster heater unit, consisting of a heater core and two motors with individual blowers, is installed in dash compartment, front of dash center closure panel (fig. 21). Air is distributed by blowers to five defroster air outlets through four flexible air ducts (fig. 20). Air can also be deflected toward driver's feet through damper controlled outlet. Outlet damper is manually controlled. An adjustable air outlet nozzle at left end of instrument panel can be adjusted to direct air toward the driver, or it can be set to direct air on the lower left corner of windshield for defrosting.

Slotted head bleeder plug is located at left-upper corner of heater core. Flow of water through heater core is controlled by control valve installed in heater core supply line.

Control valve handle is mounted on side of heater compartment at right of driver.

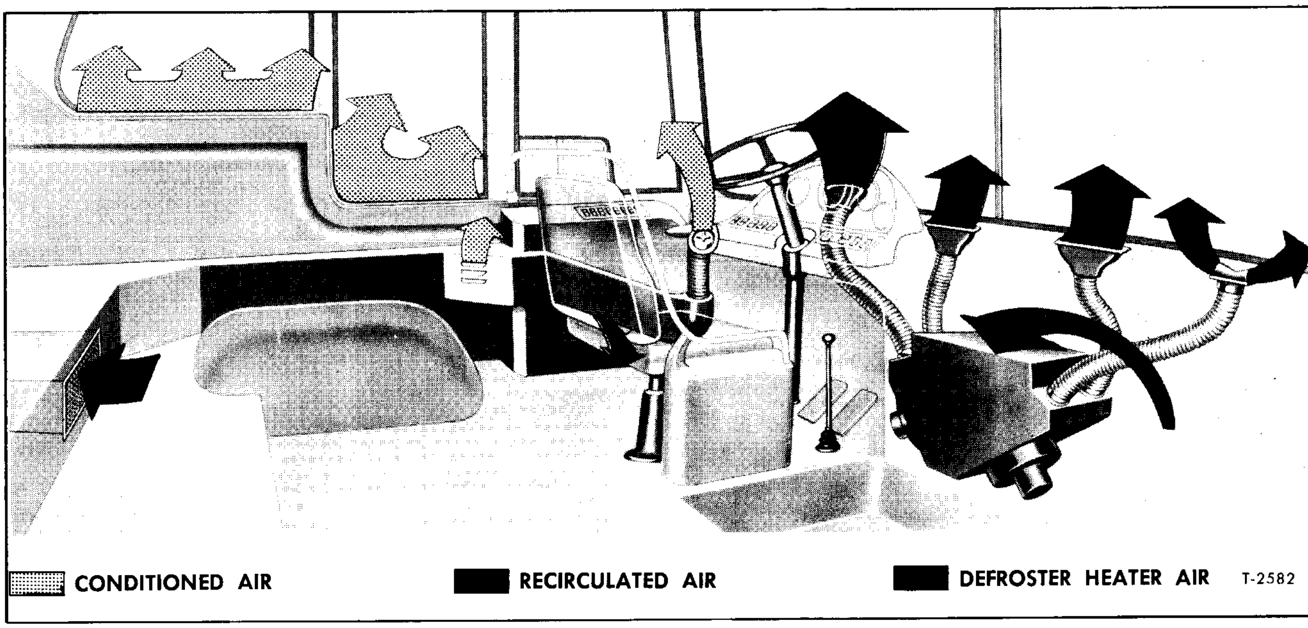


Figure 20—Air Circulation at Front of Coach

Air drawn through heater core is all recirculated air, taken in through dash compartment opening.

Defroster heater blowers and motors are mounted at underside of heater. Motors require no maintenance, and should operate indefinitely without attention. In the event of failure, motors can be disassembled, brushes replaced, and commutators turned and undercut in accordance with established practice. Whenever motor is disassembled, bearings should be lubricated at assembly. Defroster blowers are controlled by a two-speed "DEFROST" - "HI" and "LO" switch located on right side of instrument panel. Defroster motor circuit is protected by No. 8 circuit breaker on circuit breaker panel, which is located at left of driver.

Heater core, blowers, blower motors, control valve, water pipe connections, and water drain cocks are accessible after removing dash center closure panel which is attached to front end with screws.

Heater core can be removed from unit after draining system, removing heater unit panel, and disconnecting core hoses.

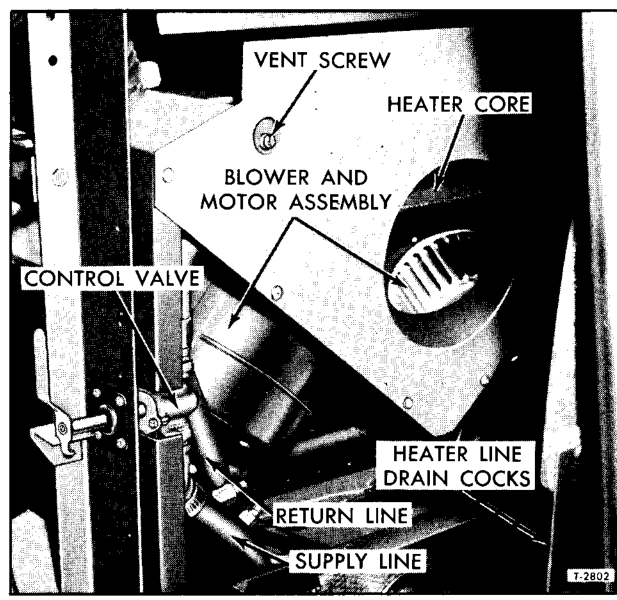


Figure 21—Defroster Heater Assembly Installed

NOTE

At regular coach inspection intervals, check operation of all heating and ventilation controls. Properly adjusted controls will assure maximum comfort for passengers and driver.

HEATING SYSTEM

SPECIFICATIONS

UNDERFLOOR BLOWER MOTOR
- Make . . . . . Delco Products
- Model . . . . . 3172916—C.C.W.
  3172917—C.W.

RPM 2100
- Horsepower 9/16
- Volts 13.7

WATER BOOSTER PUMP AND MOTOR
- G.M. Number 2479269

PUMP
- Make . . . . . Marine Products Co.
- Model 12326

MOTOR
- Make . . . . . Universal
- Model 2945-12
- Volts 12
- Amperes 18
- RPM 3400

UNDERFLOOR BLOWER MAGNETIC SWITCH
- Make . . . . . Prestolite
- G.M. Number 2482373
- Volts 12

FRONT DEFROSTER HEATER MOTORS
- Number Used 2
- Make . . . . . Universal
- Kysor Number C-11027-2
- GM Part Number 2379322
- Model 52-018
- Type . . . . . Series
- Rotation (Shaft End) . . . . . Counterclockwise
- Volts 14
- RPM 2600
- Amperes 5.0

ELECTRONIC HEATING CONTROL UNIT
- Make . . . . . Delco Radio
- Part Number 7289376

HEATING SYSTEM TROUBLESHOOTING GUIDE

TROUBLE	POSSIBLE CAUSE
UNDER-HEATING Items with an asterisk (*) also apply to under-cooling.	Heater control unit setting too low. *Defective heater control unit. *Defective underfloor blower motor. *Air filter screen dirty. Water booster pump inoperative. *Defective driver's heat control valve. Air in heating units or lines. *Clogged recirculated air inlet screen. Heater line gate or check valve closed or partly closed. *Loose wiring connections. Heater core dirty.
OVER-HEATING Items with an asterisk (*) also apply to over-cooling.	Heater control unit setting too high. *Defective heater control unit. *Defective driver's heat control valve. *Loose wiring connections.

Air Conditioning

This group, covering operation, maintenance, and repair information on GM Air Conditioning system, is divided into eight major divisions as shown in index below:

Information pertaining to a specific control, service, or test, will be found by using quick page reference index shown at beginning of each respective division.

NOTE: Air conditioning controls and units, such as temperature control, underfloor blowers, heater core unit, and air filter screen are also used in conjunction with the coach heating system. These controls and units which are common to both systems are covered in "HEATING AND VENTILATION" section of this group.

General Description

The GM coach air conditioning is designed to provide passenger comfort by cooling, dehumidifying, and filtering the air which is force-circulated within the coach as described under "GENERAL DESCRIPTION" at the beginning of this group.

The air conditioning system units are accessible in coach through access doors at left and right side of coach. System units are shown schematically in coach in figure 1.

Briefly, the air conditioning system is comprised of the following system and controls. Refer to figure 1.

THE CONDENSING SYSTEM

The condensing system consists of:

1. A Two-Cylinder Reciprocating-Type Refrigerant Compressor, shaft-driven from accessory drive take-off of coach engine. Compressor is mounted below floor, forward of engine bulkhead at left side of coach.

2. A Fin and Tube-Type Condenser Coil with a six-blade cooling fan. Condenser and fan are mounted in compartment at left side of coach. Fan blade is rotated by a hydraulic motor, driven from a hydraulic pump which is mounted to and gear driven from the engine.

3. A Liquid Refrigerant Receiver which is mounted within the condenser compartment.

THE COOLING UNITS

The cooling units consist of:

1. An Evaporator Coil of fin and tube-type construction mounted in underfloor heating and cooling compartment. Coil is accessible through forward compartment door at right side of coach.

2. A Refrigerant Expansion Valve of multi-outlet-type mounted to evaporator coil and refrigerant liquid line. Expansion valve is also accessible through compartment at right side of coach.

3. A Refrigerant Heat Exchanger of dual chamber tube unit is mounted into both high pressure liquid line and low pressure gas line. Heat exchanger is accessible through compartment at right side of coach.

4. A Dehydrator-Strainer of disposable-type is mounted in liquid line at rear of the condenser compartment.

5. A moisture indicator, installed in liquid line at outlet side of dehydrator-strainer.

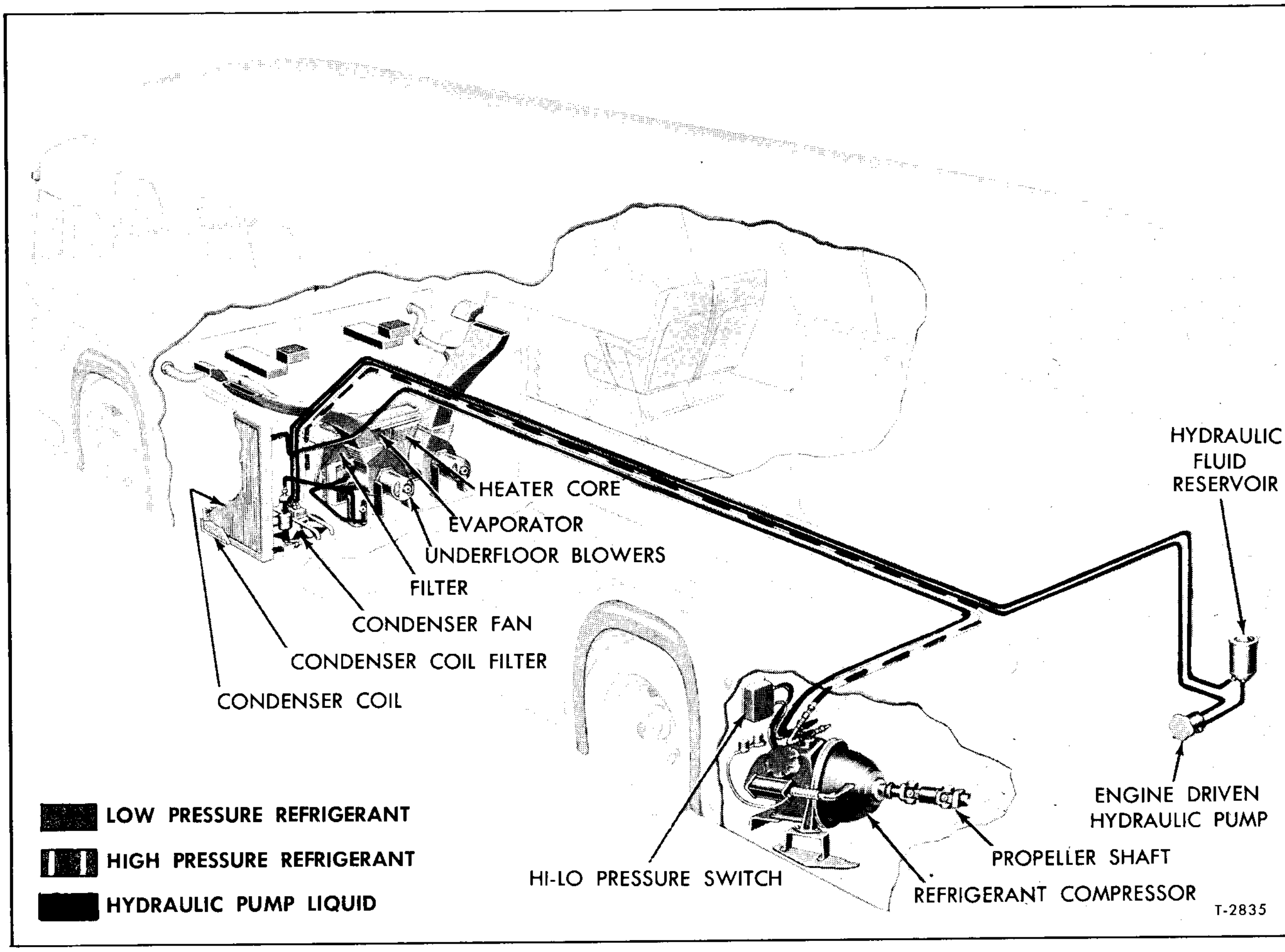


Figure 1—Refrigerant Lines and Condenser Fan Fluid Drive Lines

THE AIR CIRCULATION SYSTEM

The air circulating system consists of same air intakes, filters, blowers, and air distribution ducts which are employed for coach heating.

SYSTEM CONTROL UNITS

The air conditioning system controls consist of "HEAT-AIR COND." switch on panel at left of driver, an electrically-energized air-operated friction clutch mounted to drive end of refrigerant compressor, and several automatic controls such as pressure switches, relay, and air supply solenoid valve which are described later under "System Operation."

DRIVER'S OPERATING INSTRUCTIONS

Driver's control of air conditioning is accomplished by the positioning of switch marked "HEAT-AIR COND." mounted on control panel at left of driver.

TO OPERATE COOLING SYSTEM

With engine running at idle speed, push "HEAT-AIR COND." switch to "AIR COND." position. With switch in this position, the underfloor blower high speed circuit is energized and blower runs continuously at high speed. Except for this action, operation of the air conditioning system is completely automatic.

Temperature thermostat setting can be regulated within a range from 68°F. to 80°F., by use of dial control marked "TEMP. RANGE" on control panel at left of driver.

A short delay may occur before air conditioning system starts to operate. Two likely reasons for this condition are:

1. Engine oil pressure too high at normal idle: Engine oil pressure switch contacts will not close to complete circuit to air conditioning

controls if oil pressure exceeds 15 psi. Engagement will occur as soon as oil warms up and pressure drops below 15 psi.

2. Pressure in coach air system is low: A minimum of 65 psi air pressure is required to operate compressor clutch controls. Build up required air pressure.

NOTE: When operating system for any extended period of time while the vehicle is parked, the engine rpm should be increased to fast idle by applying the parking brake, then placing "FAST IDLE" switch on control panel at left of driver in "FAST IDLE" position.

NOTE

The "A/C STOP" tell-tale, located at left end of right side tell-tale panel in front of driver, will illuminate whenever the refrigerant "HI-LO" pressure switch contacts are open and compressor clutch is disengaged. If light stays on and coach temperature rises, report condition to service personnel.

IMPORTANT: KEEP WINDOWS CLOSED AND DO NOT LEAVE ENTRANCE DOOR OPEN ANY LONGER THAN NECESSARY.

System Operation

CONTENTS OF THIS SECTION

GENERAL OPERATION

Some controls and units used with the air conditioning system are common to the coach heating system. These controls and units are: Control switch, marked "HEAT", "OFF", and "AIR COND.", defroster control valve, underfloor air blowers, and air filter screen, heater core, and air intake and distribution ducts.

The heating and cooling systems operate independently of each other, except under certain conditions of cooling system operation when there is an overlapping operation of both systems as explained previously.

The driver can select temperature setting within a 12 degree range by using the "TEMP. RANGE" control knob on control panel.

When the "HEAT-AIR COND." switch on panel at left of driver is placed in "AIR COND." position, the air conditioning system functions as follows:

NOTE: Follow the "Heating and Air Conditioning Wiring Diagram" in the back of this manual for electrical circuits and connections.

1. With engine running and control switch closed, underfloor blower high speed circuit is energized and blower runs continuously at high speed.

2. The engine must be running at idle speed, and the air pressure in coach air system must be more than 65 psi to close low air pressure switch before circuit through the refrigerant "HI-LO" pressure switch is completed to operating coils of air conditioning control relay. With relay operating coils energized, contacts close and circuit is completed to the air conditioning drive clutch solenoid valve. Solenoid valve and relay are located in compressor compartment.

FUNDAMENTAL PRINCIPLES OF REFRIGERATION

The principle of operation of the refrigeration system is based on a few simple laws of physics which are stated informally as follows:

1. Temperature is a measurement of the intensity of heat.

2. Heat is a form of energy. When heat is added to a substance, it usually is noticed by an increase in temperature. For example, in order to raise the temperature of water from 35°F. to 100°F., it is necessary to add a certain amount of heat.

3. When an object cools, it does not absorb cold, but rather it loses heat to a colder object or substance nearby. When a bottle containing warm liquid is placed on a cake of ice, the ice will melt

and the bottle and its contents will become cool. Heat from the bottle and its contents is lost to the ice.

4. When a liquid boils, turning to vapor, it absorbs a great amount of heat. For instance, water boiling on a stove is absorbing a great amount of heat from the burner as it is changing to the vapor commonly called steam. Boiling is a rapid form of evaporation.

When a liquid boils, it absorbs heat without changing temperature. For example, when heat is added to water at sea level, as when heating on a stove, the temperature of the water will rise until it reaches 212°F. If the water remains on the hot stove, it will boil, but the temperature will remain at 212°F. The heat being absorbed by the water is changing it to steam rather than raising the temperature.

Refrigerant-22 used in air conditioning system boils at 41.7°F. below zero. Thus, if it were exposed to the air at normal room temperature, it would absorb heat from surrounding air and boil, immediately changing to a vapor.

5. When heat is removed from water vapor, it will condense back into a liquid. For example, the steam caused by boiling water on a stove will condense into water on the underside of the cover. This is due to the fact that the cover is not as hot as the steam. The cover, therefore, takes heat from the steam, condensing it back to water.

6. The temperature at which substances will boil or condense is affected by pressure. If the pressure is increased, the liquid will not boil until a higher temperature is reached. Thus, we can prevent refrigerant from boiling if it is kept under high pressure. If this high pressure is suddenly released, refrigerant will immediately boil. This has been demonstrated on modern vehicles with pressure cooling systems.

When the pressure of a vapor is increased, the temperature at which it will condense is also raised. Steam condenses below 212°F., if heat is removed from it, but it can be made to condense at higher temperature by increasing the pressure.

7. Compressing a vapor increases its temperature. For example, when pumping air into a tire with hand pump, the pump will become warm due to the heating of the air as it is compressed.

8. When a liquid is heated until it is converted to a gas, then this gas is heated additionally without changing pressure, the gas is said to be super-heated. For instance, in the evaporator refrigerant absorbs heat and boils at a constant temperature and pressure until it has been completely vaporized, and it continues to absorb heat from the warm air passing over the evaporator without any increase in pressure. Since this heat is no longer being used to convert the refrigerant from a liquid to a gas, it will now cause the temperature of the refrigerant gas to rise. The refrigerant is then superheated.

REFRIGERANT

The refrigerants used are commonly known by their trade name of Freon-22, Isotron-22, or Genetron-22. Regardless of brand, refrigerant-22 must be used. The chemical name of refrigerant-22 is monochlorodifluoromethane ($CHC1F_2$).

REFRIGERANT CHARACTERISTICS

Refrigerant exists as a gas at atmospheric pressure and must be held under pressure to remain liquid. At ordinary temperatures, it will exist as a liquid under a pressure of about 75 pounds per square inch.

Refrigerant has very little odor, but in large concentrations a distinct odor may be detected. It is colorless in both its liquid and gaseous states.

Refrigerant is nonpoisonous, nonflammable, and nonexplosive. It is noncorrosive to any of the ordinary metals.

Goggles should be worn whenever there is the slightest possibility of refrigerant coming in contact with the face or eyes, because refrigerant evaporates and cools so rapidly it will cause an injury similar to frostbite.

PROCUREMENT

Refrigerant is shipped and stored in metal drums. It is serviced in 22 and 100 lb. drums.

It will be impossible to draw all the refrigerant out of the drum. The use of warm water when charging the system will assure the extraction of a maximum amount of refrigerant from the drum. Be sure to follow the instructions under "Charging The System" explained later. NOTE: Approximately 23 lbs. of refrigerant is required in system.

PRECAUTIONS IN HANDLING REFRIGERANT

1. Do not leave drum of refrigerant uncapped.
2. Do not subject drum to high temperature.
3. Do not weld or steam clean on or near system.
4. Do not fill drum completely.
5. Do not discharge vapor into area where flame is exposed.
6. Do not expose eyes to liquid.

All refrigerant drums are shipped with a heavy metal screw cap. The purpose of the cap is to protect the valve and safety plug from damage. It is good practice to replace the cap after each use of the drum for the same reason. If the drum is exposed to the radiant heat from the sun, the resultant increase in pressure may cause the safety plug to release or the drum to burst.

For the same reason, the refrigerant drum should never be subjected to excessive temperature when charging a system. The refrigerant drum should be heated for charging purposes by placing in 125°F. water. Never heat above 125°F. or use blowtorch, radiator, or stove to heat the drum.

Welding or steam cleaning on or near any of the refrigerant lines or components of the air conditioning system could build up dangerous and damaging pressures in the system.

If a small drum is ever filled from a large one, never fill the drum completely. Space should always be allowed above the liquid for expansion. Weighing drums before and during the transfer will determine fullness of drums.

Discharging large quantities of refrigerant into a room can usually be done safely as the vapor would produce no ill effects. However, this should not be done if the area contains a flame-producing device such as a gas heater. While refrigerant normally is nonpoisonous, heavy concentrations of it in contact with a live flame will produce a poisonous gas. The same gas will attack all bright metal surfaces.

DO NOT EXPOSE EYES TO REFRIGERANT

One of the most important precautions is protection of the eyes when handling refrigerant. Any liquid refrigerant which may accidentally escape is approximately 21.7°F. below zero. If any refrigerant comes in contact with the eyes, serious injury could result. Always wear goggles to protect the eyes when handling refrigerant.

If refrigerant should come in contact with the eyes:

1. DO NOT rub the eyes. Splash the eyes with cold water to gradually get the temperature above the freezing point.
2. Apply a protective film of an antiseptic oil over the eye-ball to reduce the possibility of infection.
3. Consult a doctor or an eye specialist immediately.

Should liquid refrigerant come in contact with the skin, the injury should be treated the same as though the skin had been frostbitten or frozen.

REFRIGERANT CIRCULATION

Refrigerant control units and piping is illustrated in figure 1. A complete cycle of the refrigerating system is as follows:

1. Refrigerant in its gaseous state is drawn into the compressor where it is compressed and discharged into the condenser.
2. As the heated gas circulates through the condenser coils, it is cooled by air being forced through the condenser by a hydraulically-driven fan. The combined effects of the decreased temperature and increasing pressure cause the gas to condense (liquify).
3. The liquid refrigerant is then forced from condenser into the liquid receiver.
4. By its own pressure, liquid refrigerant is forced from liquid receiver through the dehydrator strainer and moisture indicator, then through the heat exchanger where it is cooled somewhat by the returning suction line low pressure gas. It then passes through the expansion valve into the evaporator.
5. In the evaporator, where the pressure is reduced, the liquid refrigerant evaporates, or changes into its gaseous state. As the liquid evaporates, heat is absorbed from the air passing through the evaporator coils, thus the air is cooled.
6. Flow of refrigerant into the evaporator is regulated by the expansion valve. The expansion valve is actually a pressure reducing valve which serves two purposes: a - It maintains pressure on the liquid line. b - It admits only the required amount of liquid refrigerant into the evaporator, this requirement being determined by the temperature of the gaseous refrigerant at the evaporator outlet.
7. The low pressure refrigerant gas passes from the evaporator through the heat exchanger and back through the suction line to compressor thus completing the cycle.

NOTE: Gauges for checking pressures in the refrigerant system can usually be obtained from a local refrigeration service and supply dealer.

AIR CIRCULATION

Air circulation is common to both the heating and air conditioning systems. For detailed description of air circulation in coach, refer to "Air Circulation" in "HEATING SYSTEM" section of this group.

OPERATION OF ELECTRICAL CONTROL UNITS

Refer to "HEATING SYSTEM" section of this group for operating information on controls such as: "TEMP. RANGE" control knob, air pressure regulating valve, blower motor, blower motor relay, water valve and heating system water pump.

"HEAT-AIR COND." CONTROL SWITCH

Control switch marked "HEAT-OFF-AIR COND." on control panel is a three-position rocker type switch.

With switch in "AIR COND." position, the circuit to underfloor blowers is energized causing motors to operate at high speed, and circuit is completed through the "HI-LO" refrigerant pressure switch. Circuits are shown in "Heating and Air Conditioning Wiring Diagram" in back of manual.

AIR CONDITIONING CONTROL RELAY

Air conditioning drive control relay is located in the air conditioning compressor compartment at left rear of coach as shown in figure 2.

Relay serves to close electrical circuit to compressor drive clutch air solenoid valve, causing valve to open, admitting air pressure to clutch.

Relay is a lock-in type unit; that is, after operating coils are energized and contacts close, contacts will remain closed as long as the circuit through the contacts is not broken. Either of five conditions can break the circuit and cause relay contacts to open:

1. Excessive high or low refrigerant pressure.
2. Engine stops running.
3. Low air pressure (below 65 psi).
4. "HEAT-AIR COND." switch turned to "OFF."
5. Generator system fails.

The purpose of the lock-in feature of the air conditioning control relay is to maintain circuit to air conditioning clutch solenoid valve after the engine oil pressure safety switch opens.

ENGINE OIL PRESSURE SAFETY SWITCH

Engine oil pressure safety switch is mounted in manifold on engine bulkhead. See item 4 on figure 2 in ENGINE (SEC. 8).

With engine running and oil pressure at 15 psi or more, contacts of safety switch are opened. Purpose of switch is to prevent engagement of air conditioning compressor drive clutch if driver should turn control switch to "AIR COND." position with warm engine running above 600 rpm.

CLUTCH CONTROL AIR PRESSURE SWITCH

Air pressure switch is mounted at left end of bulkhead forward of the refrigerant compressor (fig. 2). Purpose of switch is to prevent compressor drive clutch slippage which could be caused by insufficient operating air pressure.

Contacts of switch close when the air pressure in coach air system exceeds 65 psi. Switch completes circuit from "AIR COND." terminal of "HEAT-AIR COND." switch on control panel at left of driver, through the air pressure switch to

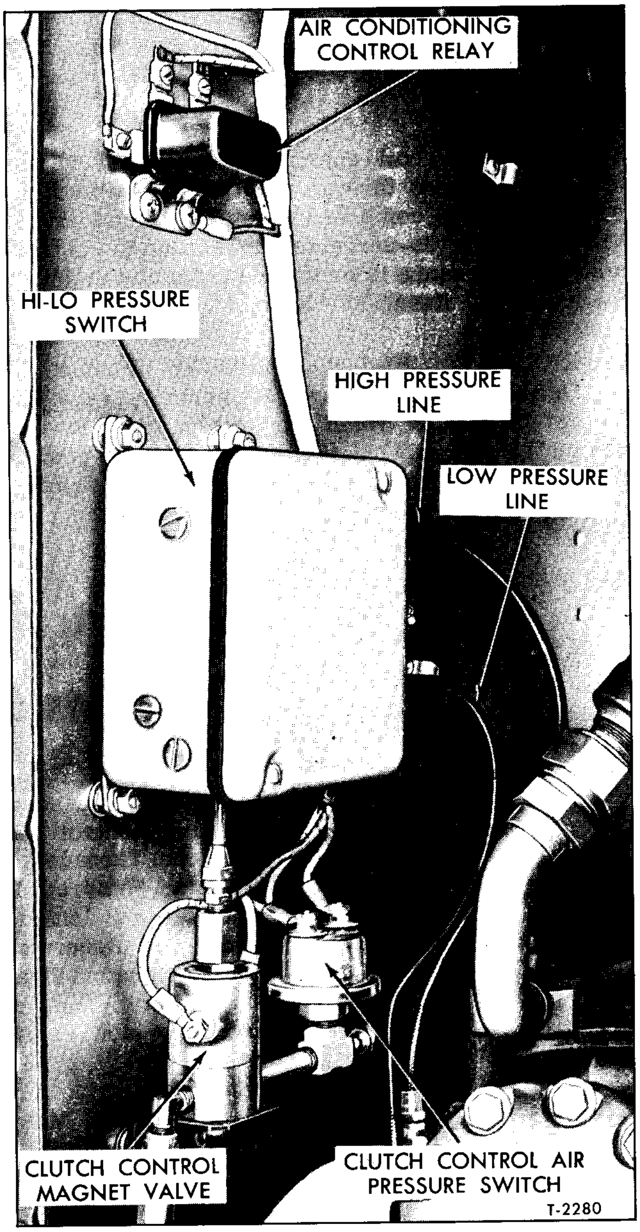


Figure 2—Air Conditioning Control Units

the engine oil pressure safety switch, and to the refrigerant "HI-LO" pressure switch, then to the air conditioning control relay as shown on "Heating and Air Conditioning Wiring Diagram" in back of manual.

COMPRESSOR DRIVE CLUTCH AIR SOLENOID VALVE

Compressor drive clutch solenoid valve (fig. 2) is mounted on bulkhead forward of the refrigerant compressor.

Air valve is an electrically-operated valve which controls flow of air pressure for the operation of compressor drive clutch. Circuit to valve

is controlled by the air conditioning control relay mounted above "HI-LO" pressure switch in refrigerant compressor compartment at left rear of coach.

With valve coil energized, air pressure is permitted to pass through valve and flexible line to engage the compressor clutch mechanism. When valve is de-energized by action of control relay, air pressure is exhausted from clutch drive mechanism to disengage clutch.

REFRIGERANT "HI-LO" PRESSURE SWITCH

Definite high and low refrigerant pressures are established at which the system will operate efficiently and safely. "HI-LO" pressure cutout switch is provided to prevent operation of system when pressures exceed these limits. The switch is located in compressor compartment (fig. 2). Switch is connected to high and low refrigerant pressures at the compressor. Current from "HEAT-AIR COND." switch is routed through the "HI-LO" pressure switch. Whenever the high or low refrigerant pressure exceeds limits, the switch interrupts compressor clutch controls to stop compressor. When this occurs, another set of contacts within control relay close to complete circuit from "HEAT-AIR COND." control switch to the "A/C STOP" tell-tale on gauge panel. Tell-tale, when illuminated, indicates that compressor is not operating. When refrigerant pressures normalize to the switch cut-in point, compressor clutch control circuit is again completed and the compressor becomes operative.

System Maintenance

CONTENTS OF THIS SECTION

REFRIGERANT HI-LO PRESSURE SWITCH

The "HI-LO" pressure switch (fig. 3) is a dual pressure control switch connected in series with the air conditioning control circuit, and actuated by the high side and low side refrigerant pressures. The control unit consists basically of two bellows, both of which are connected through spring-loaded toggle linkage to a set of contact points, all enclosed within a dust-proof case.

Low pressure cut-out and cut-in points are adjustable; high pressure cut-out point is adjustable but the differential on the high pressure side of switch is fixed and nonadjustable. Access plugs are provided in side of case to permit making adjustments with a straight screwdriver.

All four wire terminals, L1, L2, M1, and M2 are used on this installation. Either of the two bellows assemblies and the contact assembly are replaceable. When connecting lines to either

bellows, it is extremely important to use a wrench on hex portion of bellows element while tightening hose fitting to prevent damaging bellows.

The "HI-LO" pressure cut-out switch is properly set at the factory and should not normally require adjustment in the field. However, in the event of improper operation, switch operation can be tested and adjusted, if necessary, as follows:

LOW PRESSURE TEST AND ADJUSTMENT

Low pressure cut-out is an extremely important adjustment. System will not function satisfactorily and possible damage to compressor may result if switch points fail to open near the designated pressure. In making the following test, an accurate compound (pressure and vacuum) gauge should be used.

NOTE: A gauge set for checking refrigerant pressures can usually be obtained from local refrigerant sales and service dealer.

1. Remove cap from suction valve test gauge fitting, then connect gauge at low pressure line to fitting. Have an assistant close suction valve slowly on top side of compressor by turning valve stem in (clockwise) until valve seats.

2. Start coach engine and operate compressor, then observe pressure reading on gauge at the instant compressor clutch becomes disengaged and compressor stops. Switch points should open to disengage clutch at 10 psi gauge pressure.

3. Next allow pressure to build up until compressor clutch becomes engaged. Pressure reading on gauge when switch points close and complete circuit to compressor clutch drive should be 30 psi.

4. If switch points do not open and close at gauge readings specified in Steps 2 and 3, adjust as follows:

a. Remove switch cover, and remove adjusting screw access plugs from side of case.

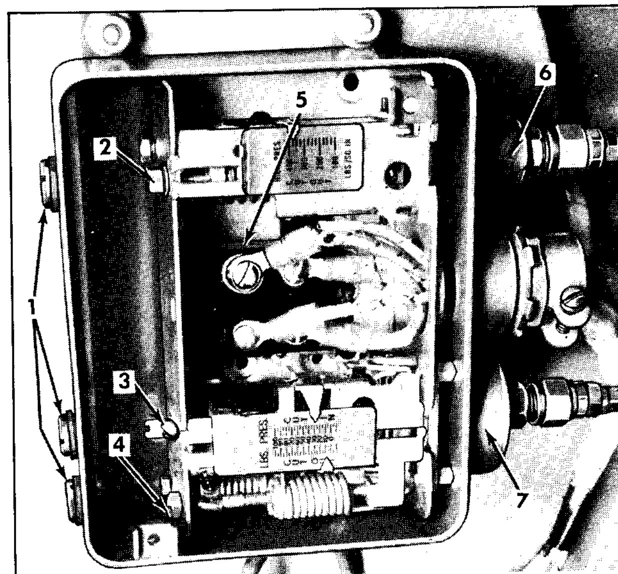
b. If only the cut-out point requires adjustment, turn adjusting screw (4). Indicator is calibrated in increments of 5 psi.

c. If the cut-in point requires adjustment, turn adjusting screw (3), which changes the cut-in and cut-out points an equal amount, then re-adjust cut-out point by turning screw (4).

d. After adjusting, recheck operation of unit as described above, then open suction valve at top of compressor.

HIGH PRESSURE TEST AND ADJUSTMENT

The high pressure side of the switch should open the points and disengage the compressor clutch at 375 psi gauge pressure, and should permit the points to close when pressure drops to 65±5 psi. The point at which the switch cuts out is adjustable, but the cut-in point is not adjustable.



1 Access Plugs	4 Low Pressure Cut-Out Adjustment
2 High Pressure Cut-Out Adjustment	5 Contact Assembly
3 Low Pressure Range Adjustment	6 High Pressure Bellows
	7 Low Pressure Bellows

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Figure 3—Refrigerant Hi-Lo Pressure Switch

Test switch and adjust if necessary as follows, using an accurate high pressure gauge:

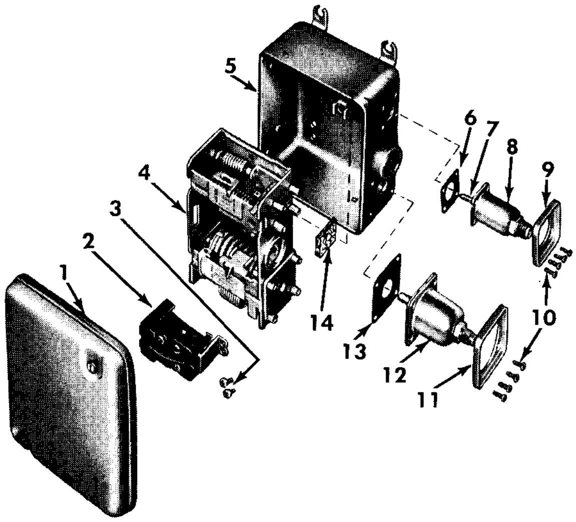
1. Remove cap from discharge valve test gauge fitting, then connect gauge set high pressure line to fitting.

2. With both the suction and discharge valves in operating position (cracked 1/2 to 1 turn away from backseated position), operate compressor. Have an assistant slowly close the discharge valve by turning valve stem clockwise and observe pressure reading on gauge the instant the compressor stops. If gauge reading when compressor stops is more or less than 375 psi, adjust by turning adjusting screw (2). CAUTION: If high pressure switch fails to disengage compressor clutch when pressure reaches 400 psi, stop compression, as pressures in excess of this may damage other units.

3. Have assistant open discharge valve, then repeat step 2 above to recheck cut-out adjustment.

4. When pressure cut-out switch stops the compressor at correct pressure, continue to operate coach engine and air conditioning system until pressure equalize, then observe reading on pressure gauge when circuit is completed to compressor clutch drive. If switch does not permit points to close at 310±5 psi gauge pressure, the complete control unit should be replaced.

5. After completing tests and adjustments, install cover and hole plugs.



1 Cover and Seal Assy.	9 Bellows Retainer
2 Switch Contact Assy.	10 Attaching Screws
3 Attaching Screws	11 Bellows Retainer
4 Switch Actuating Assy.	12 Low Pressure Bellows Assy.
5 Switch Box	13 Gasket
6 Gasket	14 Anti-rattle Pad
7 Plunger Shaft	
8 High Pressure Bellows Assy.	

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Figure 4—Hi-Lo Pressure Switch Components

PRESSURE SWITCH REPLACEMENT

1. Pump down system as directed later under "SYSTEM SERVICES AND TESTS."
2. Back-seat compressor suction valve to close line to low pressure fitting at switch.
3. Disconnect refrigerant pressure lines and immediately cap line fittings to seal moisture and air from system.
4. Reverse the above procedure to install pressure switch.
5. After installing switch assembly, place system back in operating position, then vent or crack line connections at switch. Tighten connections firmly after venting. NOTE: If system was left open for any extended period of time it may be necessary to purge system.

PRESSURE SWITCH BELLOWS AND CONTACT REPLACEMENT

NOTE: Three subassemblies of HI-LO pressure switch are available for service; the high and low pressure bellows (8 and 12, fig. 4), and the switch contact assembly (2, fig. 4). The following describes replacement procedure of above mentioned parts. Bellows should be replaced if refrigerant is leaking into switch box, which may be due to a broken diaphragm within bellows. The switch contact assembly should be replaced if arcing is noted when switch contacts open and close, or if current flow check indicates failure of current to pass through switch.

Disassembly

NOTE: Key numbers in text refer to figure 4.

1. Remove four screws (10) which attach high and low pressure bellows (8 and 12) to switch box (5). Remove bellows retainers (9 and 11), the bellows, and gaskets (6 and 13).

NOTE: Be careful not to lose plunger shaft (7) from inside of high pressure bellows (8).

2. Remove cover (1) with cover seal from switch box.
3. To remove the switch contact assembly (2), remove two small screws (3) which attach contact mounting bracket to switch box. Lift switch contact assembly from box.

Installation

NOTE: Key numbers in text refer to figure 4.

1. Attach switch contact assembly (2) to box with two small screws (3). Tighten screws firmly.
2. NOTE: A square shaped soft rubber pad (14) is located between switch box and switch actuator assembly (4) at the high pressure bellows. Bellows plunger shaft (7) must be inserted through hole in pad when installed.
3. Install high and low pressure bellows (8 and 12), gaskets (6 and 13), and retainers (9 and 11) with small screws (10). Tighten screws firmly.

IMPORTANT: Cap openings of bellows line fittings until such time switch assembly is installed.

AIR CONDITIONING CONTROL RELAY

Air conditioning control relay, mounted in air conditioning compressor compartment at left rear of coach, controls the compressor clutch solenoid valve. Relay installed is shown in figure 2.

Terminal No. 2 is fed through both air conditioning control engine oil pressure switch and from the "HEAT-AIR COND." control switch located on panel at left of driver.

Terminal Nos. 1 and 6 are fed by same circuit except that circuit does not flow through the engine oil pressure switch.

Terminal Nos. 3 and 4 are connected to relay operating coils. Terminals are fed from the No. 2 terminal of relay after current flows through closed contacts of first the low air pressure switch and then the low pressure contacts of the refrigerant "HI-LO" pressure switch.

Relay circuits are shown on "Heating and Air Conditioning Wiring Diagram" in back of this manual.

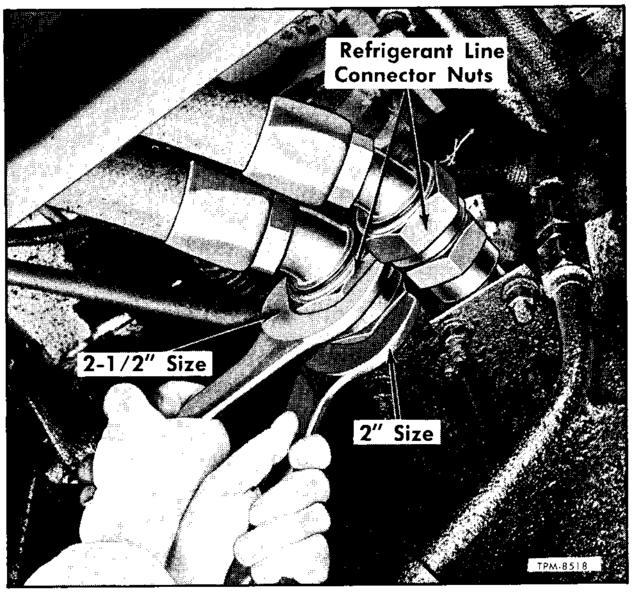


Figure 5—Using Wrenches at Line Connections (Typical)

Terminal identification numbers shown on Wiring Diagram are stamped on base of relay at side of terminals. Maintenance and repair procedures for relay are covered in "WIRING AND MISCELLANEOUS ELECTRICAL" (SEC. 7) of this manual.

REFRIGERANT LINE THREADED CONNECTIONS

To break threaded line connections use wrenches as shown in figure 5. A rubber O-ring seal (fig. 6) is used at flexible line connections and at condenser line connections to assure positive seal. A new O-ring seal should be installed when line connection has been broken.

The same method as shown in figure 5 is to be used to connect threaded lines. To connect flexible line to metal line, hand-tighten connector nut on flexible line. Place wrench on hex nut of flexible line (fig. 6) and firmly tighten connector nut with proper wrench.

If O-ring seal is used, apply clean compressor oil to O-ring seal to facilitate connection. Check for leaks as explained later under "SYSTEM SERVICES AND TESTS."

> **IMPORTANT**
>
> Use GM replacement flexible metal lines - Aeroquip type 2603. Other lines may be substituted, however, other types of lines may or may not meet the necessary requirements of this system.

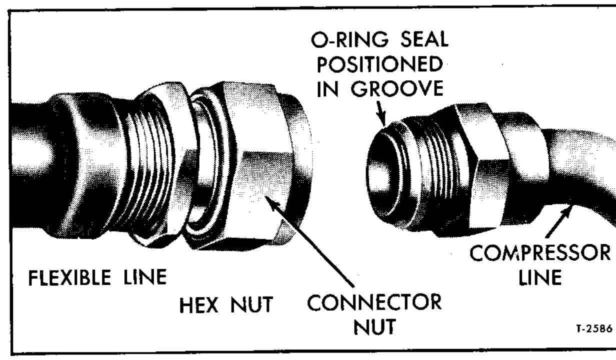


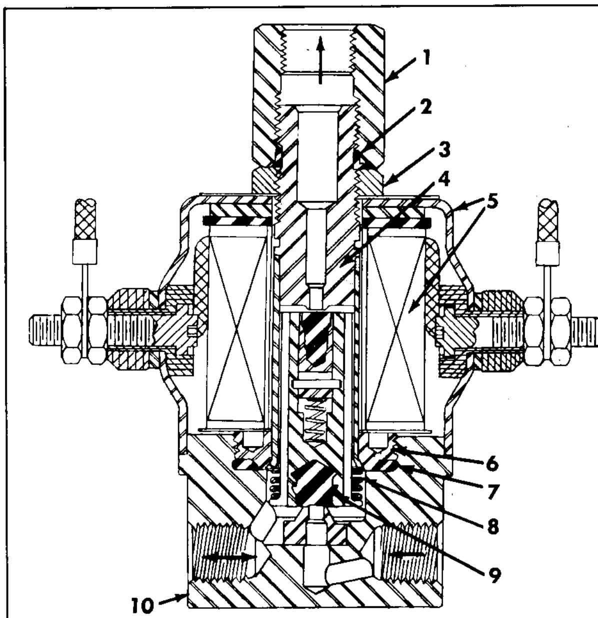
Figure 6—Refrigerant Line O-Ring Seal Installed

REFRIGERANT LINE SOLDERED JOINTS

Clean surfaces to be soldered using No. 00 steel wool, then apply thin coat of "Nokorode" flux. Sweat connection with special 95% tin and 5% antimony solder.

CLUTCH CONTROL AIR SOLENOID VALVE

Solenoid valve assembly is constructed as shown in figure 7. Foreign substances which may be present in compressed air system, may enter solenoid valve and injure valve faces and seats



1 Adapter
2 Adapter Seal
3 Thin Hex Nut
4 Sleeve Assembly
5 Housing and Coil Assy.
6 Sleeve Retaining Nut
7 Sleeve Nut Seal
8 Plunger Spring
9 Plunger Assembly
10 Valve Body TPM-5756

Figure 7—Clutch Control Air Solenoid Valve

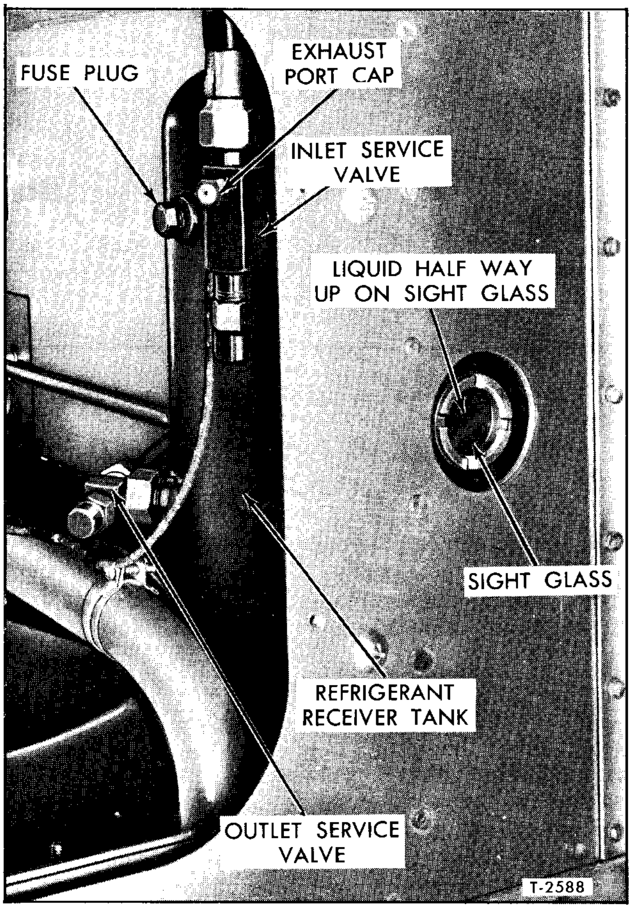


Figure 8—Refrigerant Receiver Tank and Sight Glass Location

sufficiently to permit air leakage past valve rubber inserts when valves are seated. This condition may be detected easily on vehicle or on bench by testing valve ports with soap suds.

Valve assembly can be readily disassembled for cleaning, inspection, and replacement of parts.

DISASSEMBLY

NOTE: Key numbers in text refer to figure 7.

1. Remove threaded adapter (1) and seal (2) from sleeve assembly (4), then remove thin nut (3) which retains housing and coil assembly (5) to sleeve assembly.

2. Remove housing and coil assembly (5) by sliding off upper end of sleeve assembly.

3. Using special spanner wrench (skinner No. VO-233), unscrew sleeve retaining nut (6) from valve body (10), then remove sleeve assembly (4), plunger assembly (9), and plunger spring (8) from valve body.

4. Remove sleeve nut seal (7) from valve body. Discard seals (2 and 7) and obtain new parts for assembly.

CLEANING AND INSPECTION

Wipe all parts clean with a clean cloth. Do not clean housing and coil assembly or plunger assembly in cleaning solvent. Examine rubber inserts in plunger assembly for wear or deterioration. Replace plunger assembly if damaged. Make sure valve seats on sleeve and in body are clean and smooth.

ASSEMBLY

NOTE: Key numbers in text refer to figure 7.

1. Assemble plunger spring (8) on plunger assembly (9) and position plunger in valve body.

2. Place new seal (7) in body, then install sleeve assembly (4) in body and secure with sleeve retaining nut (6). Use special spanner wrench to tighten sleeve nut.

3. Install housing and coil assembly (5) over sleeve, then install thin nut (3). Tighten nut only as necessary to seat parts solidly; overtightening will place excessive strain on sleeve assembly.

4. Place new seal (2) in groove of adapter, then install adapter (1) on sleeve. Hold nut (3) while tightening adapter.

LIQUID REFRIGERANT RECEIVER TANK

Liquid receiver (fig. 8) serves as a reservoir for a constant supply of liquid refrigerant ready for use in the evaporator. A sight glass is provided at receiver in side of tank. A light bulb, installed at upper end of tank, is illuminated when automatic switch is actuated by opening either left or right-side baggage compartment door. With light on, level of refrigerant can be readily seen in sight glass. After unit has been running for 30 minutes or more under maximum heat load, refrigerant level should be at center of sight glass. In no case should the refrigerant level be above the sight glass or below it with the system operating. Refrigerant can be added to the system at the compressor suction valve test gauge fitting as directed in "SYSTEM SERVICES AND TESTS" later.

During operation of the system, both the receiver inlet and outlet valves must be fully open. To determine if valves are fully open, remove valve stem caps and turn valve stems counterclockwise to the limit of their travel. If air conditioning system fails to function, receiver valves should be the first place to check. The system positively will not function unless both of the receiver valves are open. A fusible safety plug (212°F.) is installed near top of receiver tank as shown in figure 8.

REFRIGERANT DEHYDRATOR—STRAINER

The refrigerant dehydrator-strainer, installed in the liquid line at left side of coach (fig. 13), removes foreign matter and moisture from the refrigerant before it reaches the expansion valve.

Strainer is of the disposable type, charged with activated alumina. The complete unit is discarded and replaced with a new unit.

Chemical used in unit has a high moisture absorbing capacity. Any moisture which has been inadvertently admitted into system will be absorbed by the chemical. This does not mean that the system should not be evacuated when air and moisture has been admitted.

Whenever the system has been opened for any reason, the dehydrator-strainer should be replaced after a few hours of operation. Instructions for replacing unit are explained later in this group under "SYSTEM SERVICES AND TESTS."

MOISTURE INDICATOR

Moisture indicator (figure 8A) is installed in liquid line above dehydrator-strainer as shown in figure 13. Purpose of moisture-indicator is to show that the dehydrator-strainer has absorbed moisture to the limit of its capacity, indicating that there is an excessive amount of moisture in the system.

A sight glass is installed in the indicator body behind the knurled cap, which must be removed to observe the condition indicated. Litmus paper, secured behind the sight glass, is blue under normal conditions, and turns pink when moisture is present in the system. A colored decal on the cap shows that a blue color in the sight glass indicates a "DRY" (normal) condition and a pink color indicates a "WET" (abnormal) condition. When the excess moisture condition has been corrected, the color in the sight glass will return to blue within 12 to 24 hours.

NOTE: Disregard the "EMPTY" and "FULL" markings on the indicator cap. Always use the sight glass in the liquid receiver tank to determine level of refrigerant in the system.

The moisture indicator should be checked at periodic maintenance inspection intervals. Also, it should be checked at frequent intervals following any repair or service operation which required disconnecting a refrigerant line. Whenever the moisture indicator shows a wet (pink) condition, the dehydrator-strainer should be replaced immediately. Refer to "SYSTEM SERVICES AND TESTS" section for dehydrator-strainer replacement procedure.

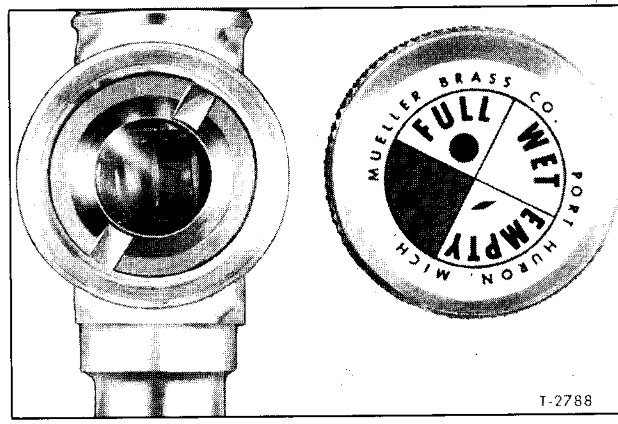


Figure 8A—Moisture Indicator with Cap Removed

EXPANSION VALVE

Expansion valve (fig. 9) is installed in the underfloor compartment at right end of evaporator coil as shown in figure 1 in "HEATING SYSTEM" section. Valve is accessible for servicing or replacement only after heating compartment access door and air filter screen have been removed. Expansion valve is set at the factory to provide the most efficient operation of the system, and should not normally require adjustment in the field. However, in the event a new evaporator coil and valve assembly or a new expansion valve power or cage assembly is installed, valve must be adjusted to provide the correct superheat at the evaporator outlet. In any event, do not adjust

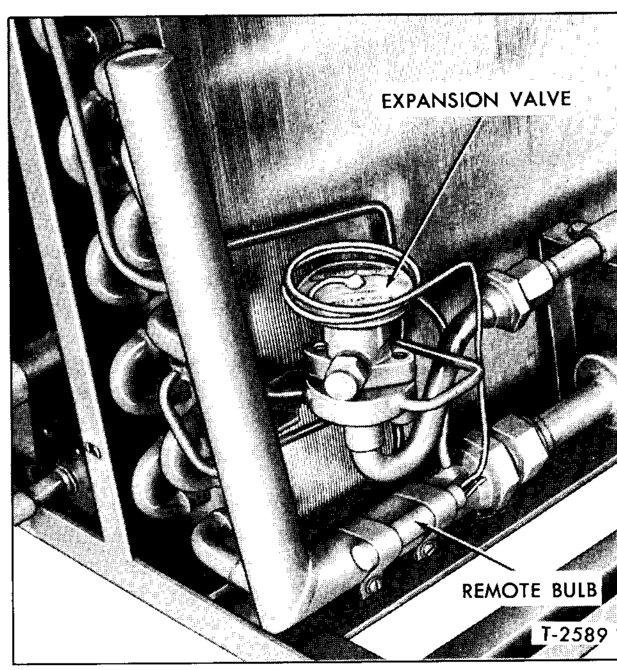


Figure 9—Expansion Valve Installed

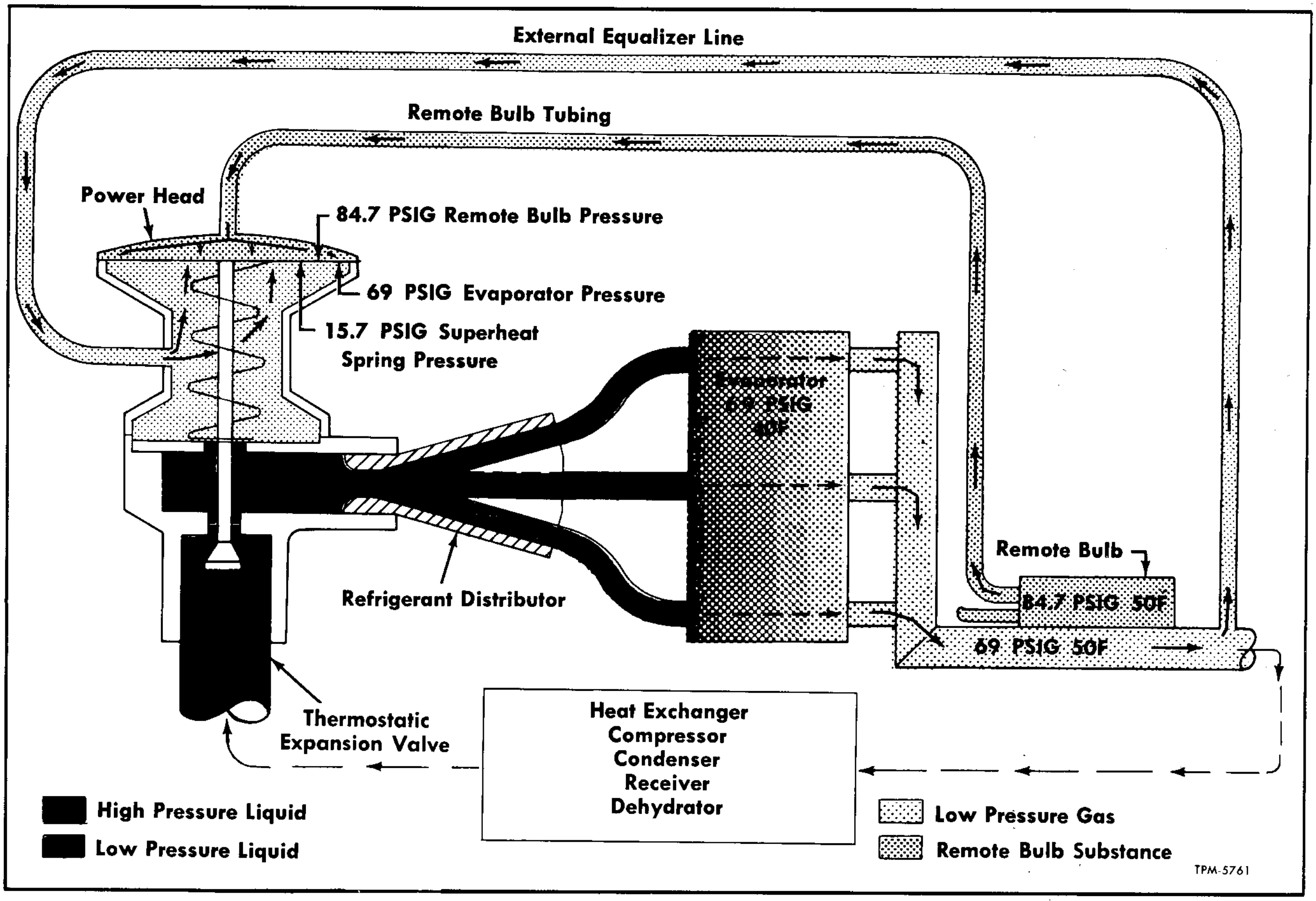


Figure 10—Simplified Diagram of Expansion Valve Operation

the expansion valve to compensate for insufficient cooling until all other possible causes are checked for and corrected.

EXPANSION VALVE OPERATION

Expansion valve is a manifold type thermo valve with external remote control bulb and external equalizer. Expansion valve regulates the flow of liquid refrigerant into the evaporator coils. Valve is primarily operated by the temperature of the suction gas leaving the evaporator, and is further controlled by the pressure in the evaporator through the equalizer tube. The combined effect of these two factors automatically control the quantity of liquid admitted into the evaporator. See figure 10, which shows schematic view of valve operation.

Outlet end of valve is of manifold type, which is connected by three small distributor tubes to the evaporator coils. The liquid line is connected to inlet port which extends through the center of the body flange. The remote bulb is clamped into the hollow end of the evaporator coil outlet manifold, where it is subjected to the temperature of the suction gas as it leaves the evaporator. Bulb is charged with gas refrigerant which expands and contracts in accordance with the temperature of the suction gas. Expansion of refrigerant in bulb applies pressure against diaphragm in valve power assembly, causing valve to open.

Bulb tends to operate valve toward its open or closed position to regulate the flow of refrigerant into the evaporator as required. If too much liquid is admitted into the evaporator, all of it does not evaporate and some liquid approaches the remote bulb, lowering its temperature. This will cause the liquid in the bulb to contract, relieving pressure on diaphragm, and spring moves valve toward its closed position. If there is not enough liquid in the evaporator, the resulting increase in temperature of the suction gas raises temperature of bulb, causing valve to operate in its opening direction.

EXTERNAL EQUALIZER

The purpose of the external equalizer is to prevent flooding the evaporator coils when temperature of evaporator suddenly rises. Equalizer tube is connected into the evaporator coil outlet manifold and to the cavity below the diaphragm in the valve power assembly. Thus, when valve is

suddenly opened wide by a high temperature in the suction gas, the heavy flow of liquid into the evaporator creates a high pressure which is carried to the underside of the diaphragm through the equalizer tube. This pressure below the diaphragm counteracts the pressure from the remote bulb and tends to move the valve toward its closed position.

CONSTRUCTION (Fig. 11)

The expansion valve has three basic component parts: The power assembly, cage assembly, and body flange. There are no working parts in the body flange. The outlet body flange is soldered to evaporator by tubes and a tube distribution manifold. Power assembly and cage assembly can be removed from the body flange without breaking any soldered connections.

Always make sure the system is clean and dry before installing the expansion valve.

SUPERHEAT

Superheat is the temperature increase of a gas, above the saturation point. When the liquid refrigerant boils or evaporates in the evaporator, heat is absorbed from the air passing through the evaporator coils, but the temperature of the gas does not rise above the boiling point until all the liquid has changed to gas. The heat thus absorbed is the latent heat of vaporization, producing a change in state with no change in temperature.

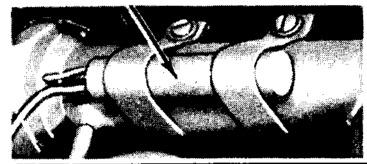
After the refrigerant has changed to gas, the temperature of the gas is still lower than the temperature of the air passing through the evaporator, so the gas will continue to absorb heat from the air and its temperature will rise a few degrees. This amount of rise above the saturation temperature is called "superheat".

Example: At 69 psi gauge pressure, the saturation temperature of refrigerant is 40°F.; that is, the liquid changes to gas at 40°F. If the temperature of the refrigerant gas at 69 psi gauge pressure is 48°F., the gas contains 8°F., of superheat. Superheating takes place after all the liquid has changed to gas, usually near the outlet end of the evaporator coils.

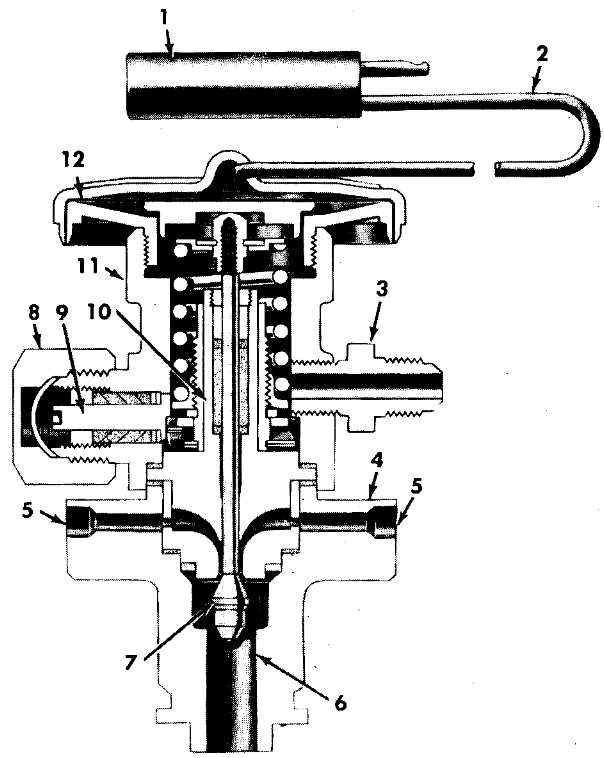
PRESSURE - TEMPERATURE

Pressure has a very definite relationship to the boiling point of any substance. There is a definite temperature at which a liquid will boil for every definite pressure exerted upon that liquid. Water, which boils at 212°F., under zero gauge pressure (atmospheric pressure at sea level), will boil at approximately 232°F., under 10 psi gauge pressure.

Likewise, refrigerant boils at -41°F. (-41°F., below zero) under atmospheric pressure, and at 40°F. under 69 psi gauge pressure. An increase in pressure causes a rise in the boiling point.



REMOTE BULB INSTALLED ON SUCTION MANIFOLD



1 Remote Bulb	7 Valve
2 Capillary Tube	8 Adjusting Stem Cap
3 Equalizer Tube Connector	9 Adjusting Stem
4 Body Flange	10 Cage Assembly
5 Outlet Ports	11 Power Assembly
6 Inlet Port	12 Diaphragm

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Figure 11—Sectional View of Expansion Valve

The pressure temperature relationships shown in the table on page 334 are used for two purposes: for adjusting the expansion valve and for checking for air in the system. Method of checking for air in the system is described in "SYSTEM SERVICES AND TESTS" later in this group.

EXPANSION VALVE ADJUSTMENT

Valve should be adjusted to obtain 8° to 12° superheat with moderately heavy internal load. Refer to pressure-temperature chart.

1. Apply small quantity of a thermo-type

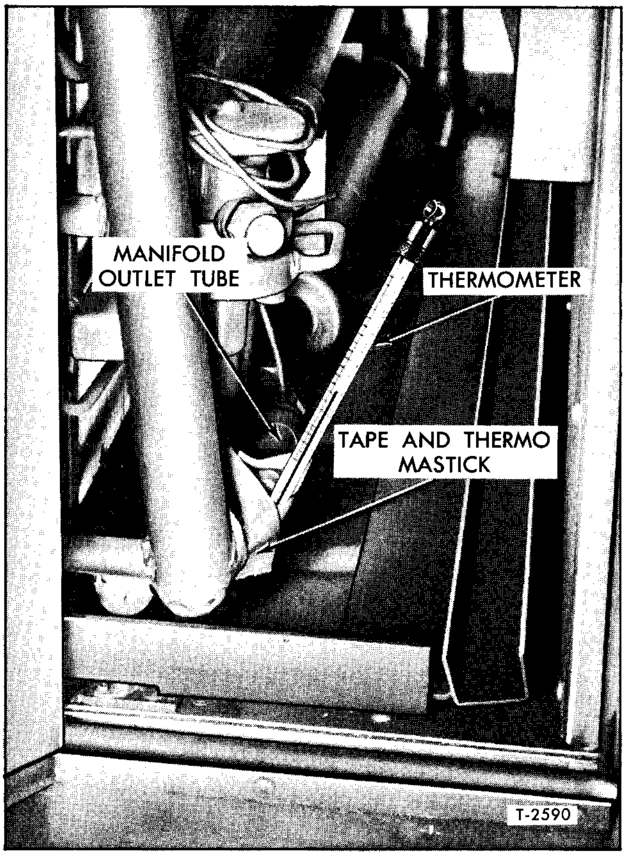


Figure 12—Checking Superheat

mastick to a remote-reading thermometer (if available) and attach to evaporator coil outlet, as shown in figure 12. Thermo-mastick may be available at a local refrigeration service establishment, or it can be obtained from the Alco Valve Company, St. Louis, Missouri. Cover thermometer more than shown.

2. Connect a low pressure gauge at the compressor suction valve test gauge fitting. Loosen line connection at gauge and expel air from line.

3. Compare pressure reading on gauge with temperature reading on thermometer against corresponding pressure in table. If necessary, remove cap from expansion valve adjusting stem; turn valve stem clockwise to decrease flow of refrigerant and increase superheat; turn valve stem counterclockwise to increase refrigerant flow and lower superheat. Two complete turns of valve stem will change the actuating superheat approximately 1°F.

4. After adjusting, wait about 30 minutes to check results.

5. Remove gauge and line, then install protector cap on test gauge fitting.

NOTE: If superheat is lower than recommended, check the following:

a. Temperature in coach may be too low.

REFRIGERANT PRESSURE - TEMPERATURE RELATIONSHIP - For F-22

Temp. °F.	Gauge Pressure Psi	Temp. °F.	Gauge Pressure Psi
30	55	96	187
32	58	98	192
34	61	100	198
36	63	102	204
38	66	104	210
40	69	106	216
42	72	108	222
44	75	110	229
46	78	112	235
48	81	114	242
50	85	116	249
52	88	118	256
54	92	120	263
56	95	122	284
58	99	124	292
60	103	126	299
62	106	128	306
64	110	130	313
66	114	132	321
68	118	134	329
70	123	136	337
72	127	138	345
74	131	140	353
76	136	142	361
78	140	144	370
80	145	146	379
82	150	148	389
84	155	150	399
86	160	152	407
88	165	154	416
90	170	156	426
92	175	158	437
94	181	160	448

b. Expansion valve adjustment necessary.

If superheat is higher than recommended, check the following:

a. Expansion valve adjustment necessary.

b. Defect in expansion valve.

c. Low on refrigerant.

d. Obstruction in system low pressure side circuit.

SERVICING THE EXPANSION VALVE (Fig. 11)

When necessary to clean, inspect, or replace parts, the power assembly and cage assembly may be removed without disconnecting any soldered joints.

1. Pump down the system as directed in "SYSTEM SERVICES AND TESTS," later in this group.

2. Disconnect the external equalizer line from power assembly. Unclamp remote bulb from evaporator coil outlet manifold tube. Use care to prevent kinking or otherwise damaging capillary tubing.

3. Remove two cap screws attaching power assembly to body flange, remove power assembly, then lift out cage assembly.

4. When assembling valve, replace gaskets in proper places, and be sure the retaining pin on the valve cage enters the slot in the body flange.

5. Make sure the two lugs on the valve cage fit into grooves in the power assembly, and that the gear wheel on cage assembly meshes with adjusting gear in side of power assembly. Do not force the valve together - make the cage fit properly before tightening to the body flange.

CAUTION: If necessary to make soldered connections at body flange, first remove power assembly, cage assembly, and all gaskets. Keep heat away from all valve parts except the body flange.

6. Clamp remote bulb to evaporator coil tube manifold, making sure there are no sharp bends or kinks in the capillary tube.

EXPANSION VALVE FREEZES

Expansion valve trouble caused by moisture in system may be usually detected by observing the moisture indicator (refer to page 331). Excessive refrigerant causes a hissing sound accompanied by a pounding vibration. When operating at low temperatures, moisture is indicated by the above, and by the fact that when the compressor is shut down and the valve warms up, it will become operative again for a short time.

If there is moisture in the system, it is necessary to evacuate the system with a vacuum pump, then service the dehydrator-strainer. If moisture is still evident after one hour of operation, the dehydrator-strainer must be serviced again. Repeat until all moisture has been eliminated. Moisture trouble is caused by moist air entering piping when system is open, or from water in refrigerant container. Piping should be blown out with refrigerant before making final connections, particularly if piping has been open to air with high humidity content. After system has been pumped down and system opened, moisture is almost certain to be introduced. Always service the dehydrator-strainer whenever the system has been opened and service again after a few hours of operation.

Many chemical preparations to be added to the refrigerant are now offered commercially for correcting moisture trouble. These preparations are anti-freeze solutions and are not suitable for use in compressor used in this system.

THE BEST PRACTICE IS TO ALWAYS SERVICE THE DEHYDRATOR STRAINER WHENEVER THE SYSTEM HAS BEEN OPENED.

This absorbs the moisture rather than preventing it from freezing, and also eliminates the danger of corrosion of internal parts of system caused by the presence of moisture.

EVAPORATOR

Finned tube type evaporator coil assembly is mounted in heating and cooling compartment under floor as shown in figure 1 in "HEATING SYSTEM" section. If the underfloor air filter screen installed forward of the evaporator is serviced frequently enough, there should be no maintenance required on the evaporator. However, if servicing the filter is neglected, some particles of dust, lint, etc., may pass through the filter; since the evaporator coils and fins are moist, these particles will cling to them. Dirt on the coils and fins acts as insulation and reduces the efficiency of the system, and when operating in humid climates, objectionable odors may develop caused by a mold-like formation or growth. In the event the evaporator does become dirty, it must be cleaned with air pressure and water and some cleaning agent which is not harmful to the aluminum tubes and fins. Since the location of the evaporator is not conducive to thorough cleaning in the vehicle, and considerable time is required for removing the evaporator for cleaning; the importance of cleaning or changing the air filter at frequent intervals should be impressed upon all maintenance personnel.

AIR FILTER SCREEN

AIR FILTER SCREEN, LOCATED IN THE UNDERFLOOR COOLING AND HEATING COMPARTMENT, MUST BE KEPT CLEAN FOR SATISFACTORY OPERATION OF AIR CONDITIONING SYSTEM.

Instructions for cleaning the air filter screen are explained in "HEATING SYSTEM" section.

UNDERFLOOR BLOWER AND MOTOR

Complete maintenance instructions on the underfloor blower and motor are covered in "HEATING SYSTEM" section.

CONDENSER COMPARTMENT

Condenser compartment is located on the left side of the coach, forward of the forward baggage compartment. Compartment contains the condenser coil, filter screen, condenser cooling fan, fan motor, dehydrator-strainer, moisture indicator, and refrigerant receiver tank. Figures 13 and 14 show components of compartment.

Access to the condenser coil and filter screen is through the condenser compartment door on left side of coach. Access to the condenser cooling fan, fan motor, dehydrator-strainer, moisture indicator, and receiver tank is through left opening in forward baggage compartment bulkhead.

CONDENSER COIL

The condenser coil (fig. 14) is the medium through which the heat picked up by the refrigerant in the evaporator and the heat of compression is dissipated to the air. Since the heat in the gas must be dissipated through the walls of the coils and the fins, it is of extreme importance that the condenser be kept clean. When condenser becomes clogged or coated with dirt and road film, high head pressure occurs and extra operating power is required. Condenser must be cleaned at regular intervals.

THE IMPORTANCE OF KEEPING THE CONDENSER CLEAN CANNOT BE OVER-EMPHASIZED. Instructions for cleaning condenser coil are explained later under "SYSTEM SERVICES AND TESTS."

CONDENSER FILTER SCREEN

(Refer to figure 14)

Air filter (5), mounted in front of condenser coil (6), filters all air passing through to con-

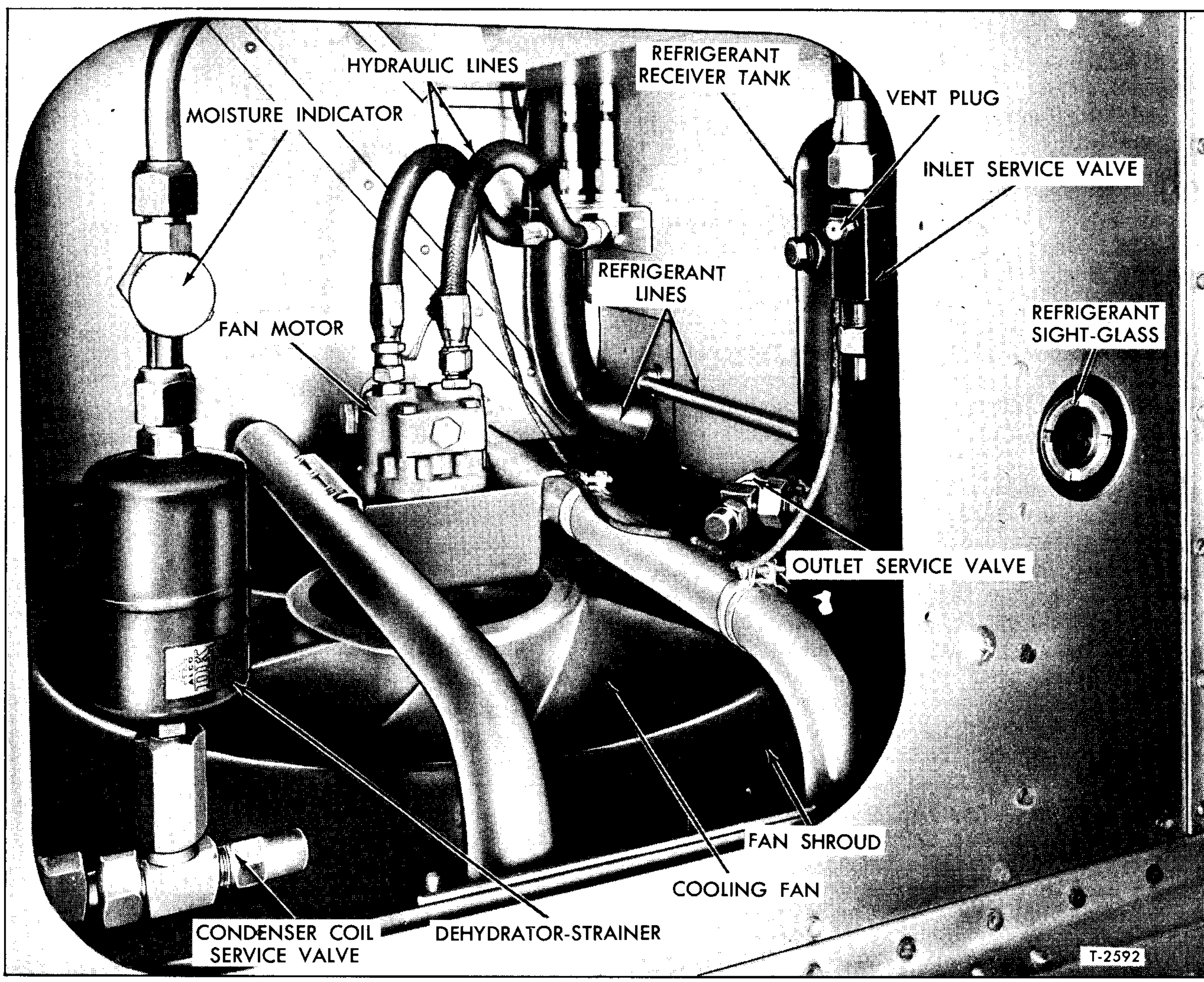


Figure 13—Condenser Compartment Viewed Through Bulkhead

denser coil. Filter is accessible after opening condenser compartment door on left side of coach. Filter can be removed as follows:

1. Turn fasteners (1) one quarter turn. Swing out filter and filter frame assembly.
2. Remove two screws, washers, and nuts (2) securing retainer (3) to frame assembly (4). Remove retainer.
3. Slide filter (5) out of frame assembly (4).
4. Clean filter as previously explained in "HEATING SYSTEM" section under "Underfloor Air Filter Screen" (except Do Not Oil).

Install filter as follows:

1. Slide filter (5) into frame assembly (4).
2. Install and secure retainer (3) to frame assembly with two screws, washers, and nuts.
3. Swing filter and frame assembly toward condenser coil and turn fasteners (1) one quarter turn to secure filter and frame assembly.

Clogged filter screen restricts air circulation, thus reducing efficiency of system. In addition to the effect on system operation, dirty filter will permit dirt to pass into condenser coil, clogging coils and fins.

CONDENSER FAN AND DRIVE

Condenser cooling fan is hydraulically driven by a fluid motor and pump. Pump is mounted on engine and connected to fan motor with two fluid lines. Figure 15 schematically shows locations of system units and lines. Location of fan and motor is shown in figure 13.

Condenser fan is of six blade type and is mounted in bottom of condenser compartment. Fan pulls outside air through the condenser coil and discharges it through screened opening at bottom of compartment.

Fan drive motor and fluid pump are gear-type and provide variable speed corresponding with rpm of engine.

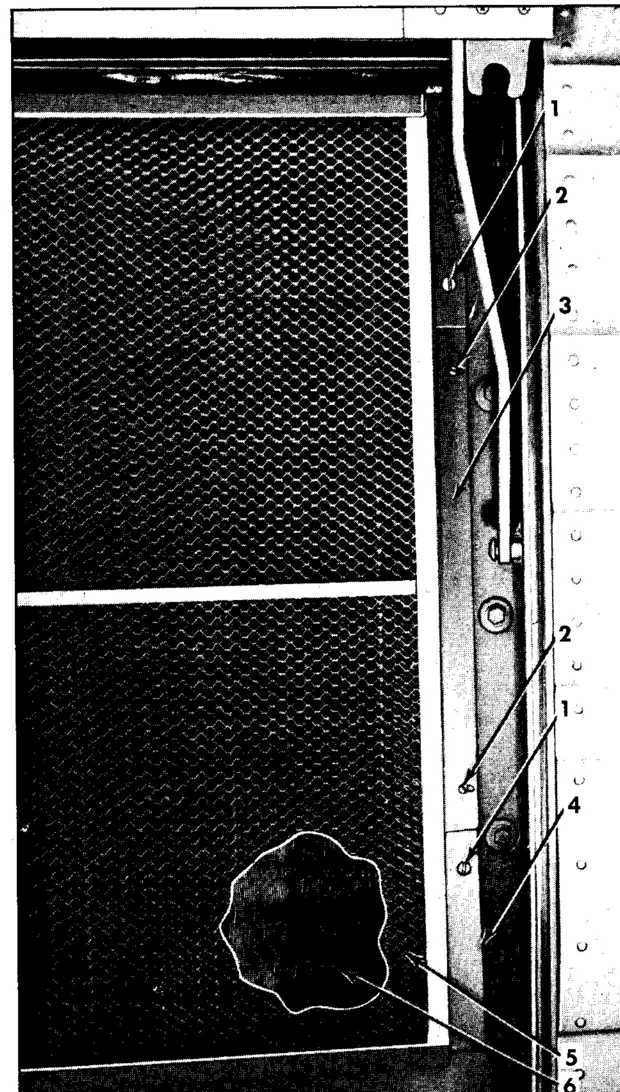
The fan blade is adjustable on motor shaft to provide alignment with shroud opening. Instructions for aligning fan blade are explained later under "Fan Blade Replacement."

The hydraulic fluid reservoir, which contains a reserve supply of system fluid, is mounted to support on engine cradle in right side of engine compartment. Instructions for filling reservoir are explained later under "SYSTEM SERVICES AND TESTS." See "Servicing Condenser Fan Drive Fluid System."

DESCRIPTION AND OPERATION

The condenser fan drive consists of a fixed displacement gear pump and motor. Their displacement being alike, one revolution of the pump results in one revolution of the motor. Actually, there are slip losses in each of the elements; therefore, in order to obtain a given speed on the motor, the pump will have to be rotated slightly faster.

The system is designed to maintain a fan speed of 1700 rpm at coach cruising speed (1650 engine rpm). At speeds less than cruising, the condenser fan speed will fall in direct ratio to the engine speed. At speeds above cruising, the load on the fan, which is approximately 3 horsepower, determines the maximum pressure and speed on the fan. If pressure becomes excessive at high engine speeds, motor relief valve will open to maintain a maximum of 2000 psi. At this pressure, fan speed will exceed 1700 rpm.



1 Fastener	4 Frame Assembly
2 Screw, Washer and Nut	5 Air Filter
3 Retainer	6 Condenser Coil

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Figure 14—Condenser Coil and Filter

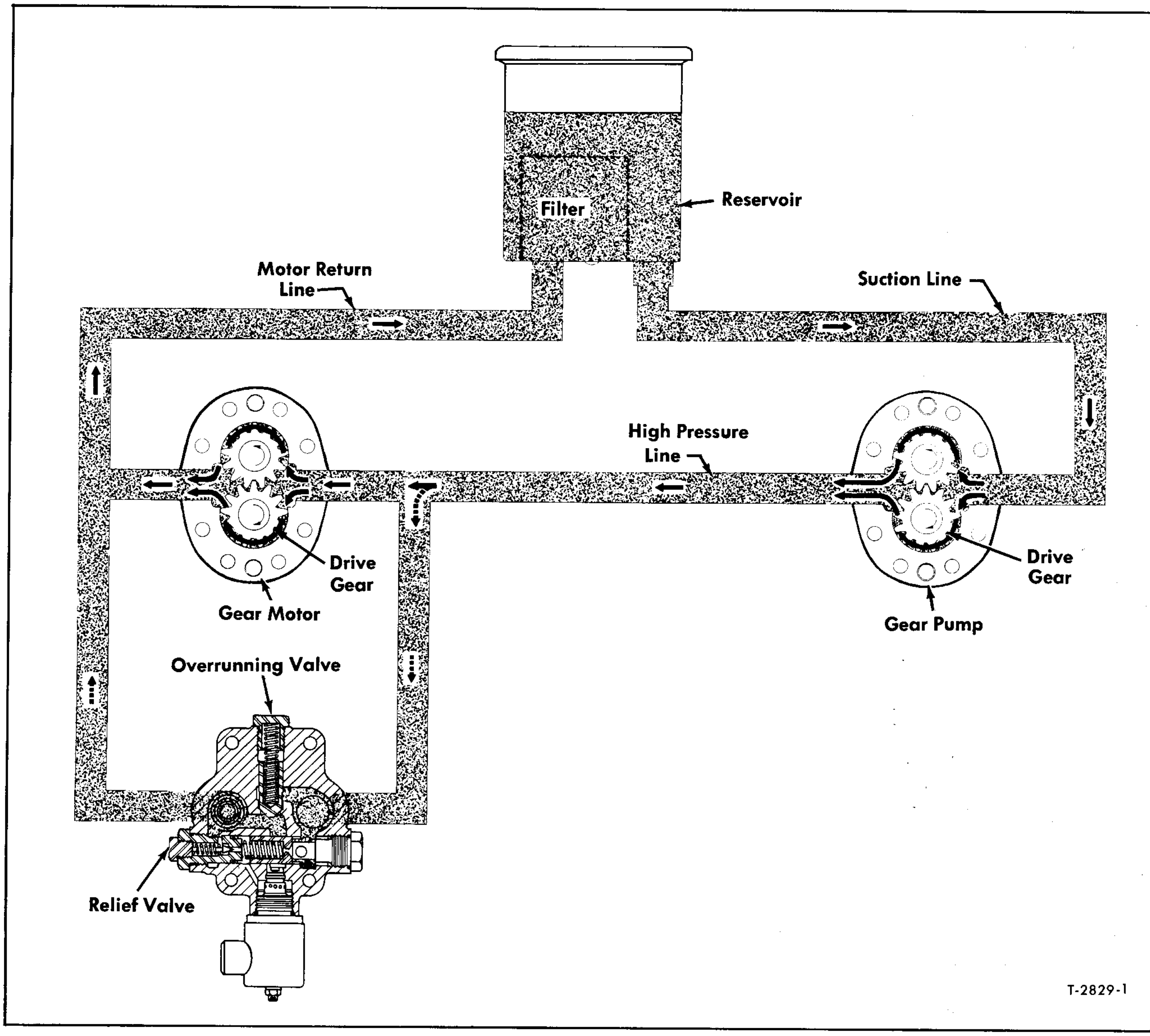


Figure 15—Schematic Diagram of Condenser Fan Fluid System

Referring to figure 15, the valve block assembly containing the relief valve and overrunning valve is actually an integral part of gear motor. The relief valve is set at 2000 psi and limits the maximum pressure. The over-running valve is normally closed and comes into operation when the engine is decelerated and the fan tends to over-run. At this time the over-running valve opens and short circuits the oil passage to keep the motor from cavitating so long as the inertia load is still on the motor.

Referring to figure 15, the pump pulls oil from the reservoir through the suction line and discharges under pressure to the gear motor. The discharge from the gear motor runs back through the filter in the reservoir.

CHECKING THE SYSTEM OPERATION

In checking the system operation the input speed must first be determined. Set the engine at 1650 rpm (cruising speed) and with a tachometer check output speed at the gear motor. The motor speed should be at least 1700 rpm. Also at this point the system pressure should not exceed 2000 psi. The relief valve controls the maximum pressure. While there is no adjustment for this, shims are used under the valve spring to determine the maximum setting.

It is also possible to check the motor speed at less than cruising speed. When this is done it is still necessary to know the input speed of the pump. Output speed of motor will usually be at least 200 rpm less than input speed of pump.

FAN DRIVE MAINTENANCE

The condenser fan hydraulic fluid level should be checked at regular coach lubrication intervals. If necessary, add Type "A" automatic transmission fluid, as explained later under "SYSTEM SERVICES AND TESTS." IMPORTANT: DO NOT OVERFILL.

Filter element in reservoir should be changed at beginning of operation season. Instructions for replacing element are explained later in this section under "Condenser Fan Fluid Reservoir."

At regular intervals all hydraulic lines and line connections should be checked for leakage. Inspect lines for possible chafing at supports to coach body. If this condition is found, lines should be repositioned and insulated. NOTE: Well insulated lines will reduce system noise.

FAN BLADE REPLACEMENT

Removal

1. From underneath coach, remove filter screen over bottom opening of condenser compartment.
2. Loosen three cap screws which secure fan blade to fan hub (fig. 16). Screws should be loosened to relieve clamping effect of fan hub on motor shaft.
3. Install three long puller screws in tapped holes of fan hub shown in figure 16, then tighten screws evenly to separate fan from hub and to force from motor shaft. Remove hub and fan blade.

CAUTION: Handle fan blade carefully.

Installation

NOTE: Fan hub should be opened slightly (wedge and press) to permit installation over motor shaft.

1. Position fan blade over taper of fan hub and secure loosely with three attaching cap screws.
2. Locate drive key into keyway of motor shaft, then slowly place fan blade and hub over motor shaft and into alignment with shaft key. Push fan hub onto shaft to a position whereby the leading edge of blade fin is flush with edge of shroud opening rim. Tighten three attaching cap screws alternately to 80 to 85 inch-pounds torque.
3. Install and secure filter screen to bottom opening.

CONDENSER FAN FLUID RESERVOIR

Fluid reservoir used in the fan hydraulic drive system is the same as used in the Power Steering Hydraulic System. For Maintenance Instructions refer to "Power Steering Fluid Reservoir" in "POWER STEERING" (SEC. 16) in this manual.

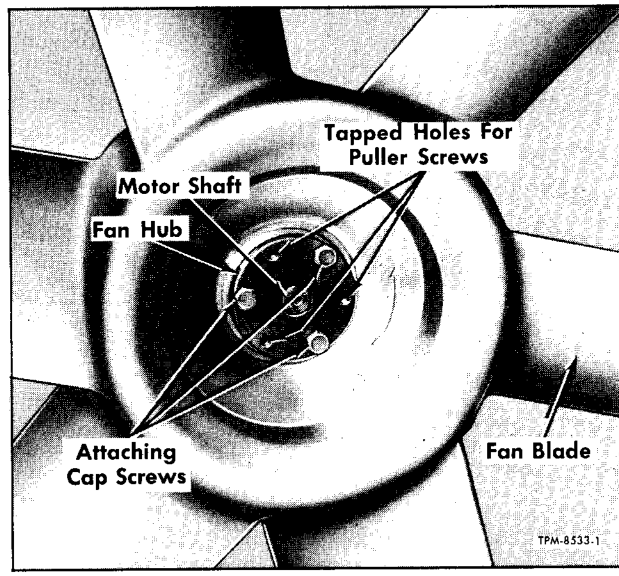


Figure 16—Condenser Fan Blade Installation

FAN DRIVE MOTOR REPLACEMENT

REMOVAL

1. Remove fan blade from motor as explained previously under "Fan Blade Replacement."
2. Having a clean container available, break line connections at motor; then let lines drain into container.
3. Remove bolts which attach motor to motor mounting bracket. Remove motor assembly.

INSTALLATION

1. Place motor assembly to mounting bracket and attach with two bolts, nuts, and washers. Make sure bolts are inserted from fan side of bracket. Tighten bolt nuts to 25 to 30 foot-pounds torque.
2. Connect hydraulic lines to motor as shown in figure 13. Tighten line connections firmly.
3. Install fan blade to motor shaft as explained previously under "Fan Blade Replacement."
4. Fill hydraulic system with required amount of fluid. Refer to "SYSTEM SERVICES AND TESTS" under "Servicing Condenser Fan Drive Fluid System" for filling instructions.

FAN DRIVE PUMP REPLACEMENT

REMOVAL

1. Drain condenser fan fluid system by disconnecting both fluid lines at pump. Drain fluid

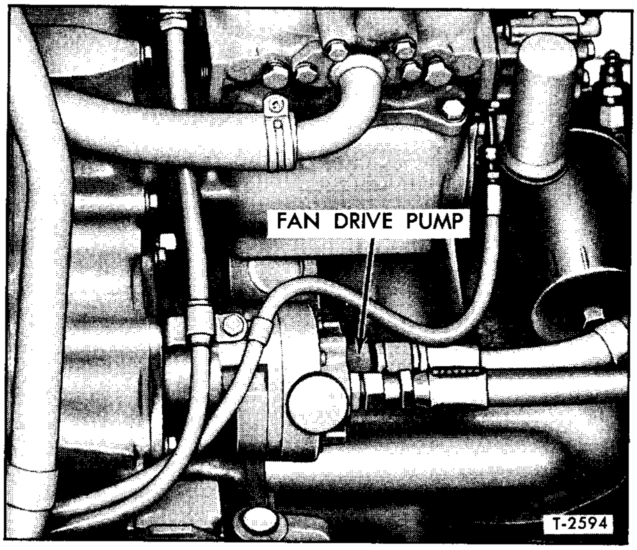


Figure 17—Fan Drive Pump Installed

into clean container, then cover container. Cap ends of lines and holes in pump to prevent dirt from entering system.

2. While supporting pump (fig. 17), remove six bolts and washers attaching pump to engine. Remove pump, gasket, and phenolic coupling.

NOTE: When removing bolts, note size and location for reassembly purposes.

3. Using suitable puller, remove pump hub from pump shaft.

INSTALLATION

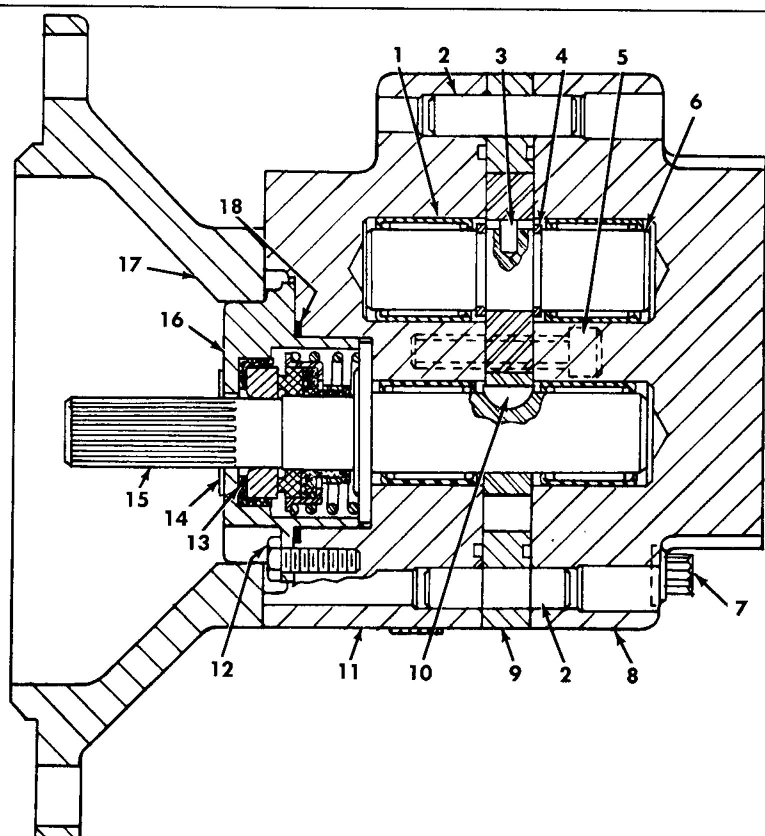
1. Install pump hub onto pump shaft.
2. Position phenolic coupling on accessory drive hub.
3. Position gasket and pump to engine and secure with attaching parts. Tighten bolts to 25 to 30 foot-pounds torque.
4. Connect fluid lines to pump ports. Tighten connections firmly.
5. Fill fluid system as instructed later under "SYSTEM SERVICES AND TESTS."

FAN DRIVE PUMP OVERHAUL

DISASSEMBLY

(Key numbers in text refer to figure 18.)

1. Remove two hex head cap screws and washers securing mounting bracket (17) to pump



1 Bearing
2 Dowel Pin
3 Pin
4 Retaining Ring
5 Screw, Socket-head
6 Idler Shaft
7 Screw
8 Port Housing Assembly
9 Plate Assy. - Spacer
10 Key
11 Mounting Housing Assy.
12 Hex-head Screws
13 Seal Assembly
14 Retaining Ring
15 Drive Shaft
16 Pilot
17 Mounting Bracket
18 Lathe Cut Washer

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Figure 18—Sectional View of Fan Drive Fluid Pump

assembly. Separate bracket from pump assembly.

2. Remove retaining ring (14).

3. Remove bolts (12) which secure pilot (16) to mounting housing (11). Slide pilot (16) with seal seat and gasket out of housing and off shaft (15).

4. Remove seal gasket and seal seat from pilot.

5. Using fingers, remove seal face (fig. 19) from shaft. Do not use metal tools as edges of seal face may be chipped.

6. Using needle-nosed pliers, remove shell, friction washer, and spring (fig. 19) from shaft.

7. Remove lathe cut washer (18).

8. Scribe a mark across pump body to assure original positioning of parts when assembling pump later.

9. Through ports in housing (8), loosen the socket-head cap screws (5). Loosen the counter-bore screws (7) which hold pump components together.

10. Insert punch in dowel holes of mounting housing (11) and drive out two dowel pins (2).

11. Remove all screws (5 and 8) loosened in step 9.

12. Using a soft lead hammer, tap alternately on ears of the two housings (8 and 11) to gradually separate the pump sections. The port housing (8) must be removed first, then remove the spacer plate and gears (9) with idler shaft (6). Drive shaft (15) cannot be removed from mounting housing (11) until gear key (10) has been removed.

CAUTION: DO NOT ATTEMPT TO PRY SECTIONS APART AS DAMAGE TO LAPPED SEALING SURFACES WILL OCCUR. Do not nick lapped surfaces of mounting housing (8), plate assembly (9), and port housing (11).

13. After pump drive gear has been removed from drive shaft (15), remove key (10) from shaft, and slide drive shaft out through bearing in mounting housing (11).

14. To remove gear from idler shaft (6), remove gear retainer rings (4) from shaft grooves, then slide gear off shaft and remove pin.

15. If inspection reveals a need for replacing shaft bearings (1), a suitable puller can be used to remove each bearing assembly from respective housing bore. Bearings will usually be damaged in the removal operation.

CLEANING AND INSPECTION

Key numbers in text refer to figure 18.

1. Wash all parts in cleaning solvent.

2. Inspect shaft surfaces which are contacted by bearings. If wear or scoring is evident, new shaft should be installed.

3. Inspect thrust face on drive shaft flange where contact is made with mounting housing; also inspect mating contact surface on housing (8). If the thrust surfaces are worn or scored, new parts should be used when assembling pump.

4. Carefully inspect pump gears and spacer plate. If sides of gears or gear teeth are worn, replace spacer plate and gears as a matched unit.

5. Inspect all of the components of drive shaft seal assembly (fig. 19). Use a new seal assembly when assembling pump if any of the parts are found to be defective or damaged.

IMPORTANT: After inspection, cover all parts to prevent dust or foreign matter from collecting on surfaces. Absolutely no dirt should be permitted on any part to be assembled.

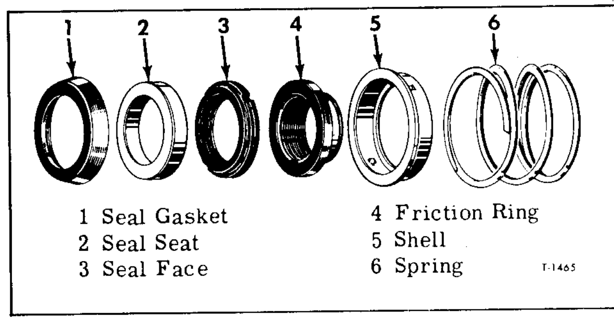


Figure 19—Hydraulic Pump and Motor Shaft Seal Components

ASSEMBLY

Key numbers refer to figure 18.

1. If shaft bearings (1) have been removed from either housing (8 or 11), use suitable installer to press new bearings into housing bores. Bearings must be located as shown in figure 18, i.e., far enough into bore so that when pump is assembled, the retaining rings (4) on idler shaft (6), and gear key (10) will not contact bearing housings.

2. Lubricate drive shaft surfaces with light weight engine oil, then insert drive shaft (15) through bearing in mounting housing (11) and install gear key (10) in keyway.

3. If gear has been removed from idler shaft (6), install pin (3) in keyway and install one retaining ring (4). Install gear on shaft, then install other retaining ring (4).

4. With mounting housing and drive shaft supported with spacer plate side facing upward, and light weight engine oil applied to gears, bearings and shaft surfaces, insert idler shaft (6) into bearing in mounting housing (11). Install gear on drive shaft (15) with keyway in gear engaged with key (10).

5. Place spacer plate assembly over gears, with alignment mark made at disassembly aligned with mark on mounting housing. Dowel pins will guide the spacer plate into position.

6. Referring to mark made at disassembly, install port housing assembly (8) over ends of shafts (6 and 15) and dowel pins (2).

7. Through port openings in housing (8), install socket head cap screws (5). Tap housings with lead hammer as cap screws (5) are tightened to seat the housings at spacer plate.

8. Install cap screws (7) and tighten with socket wrench.

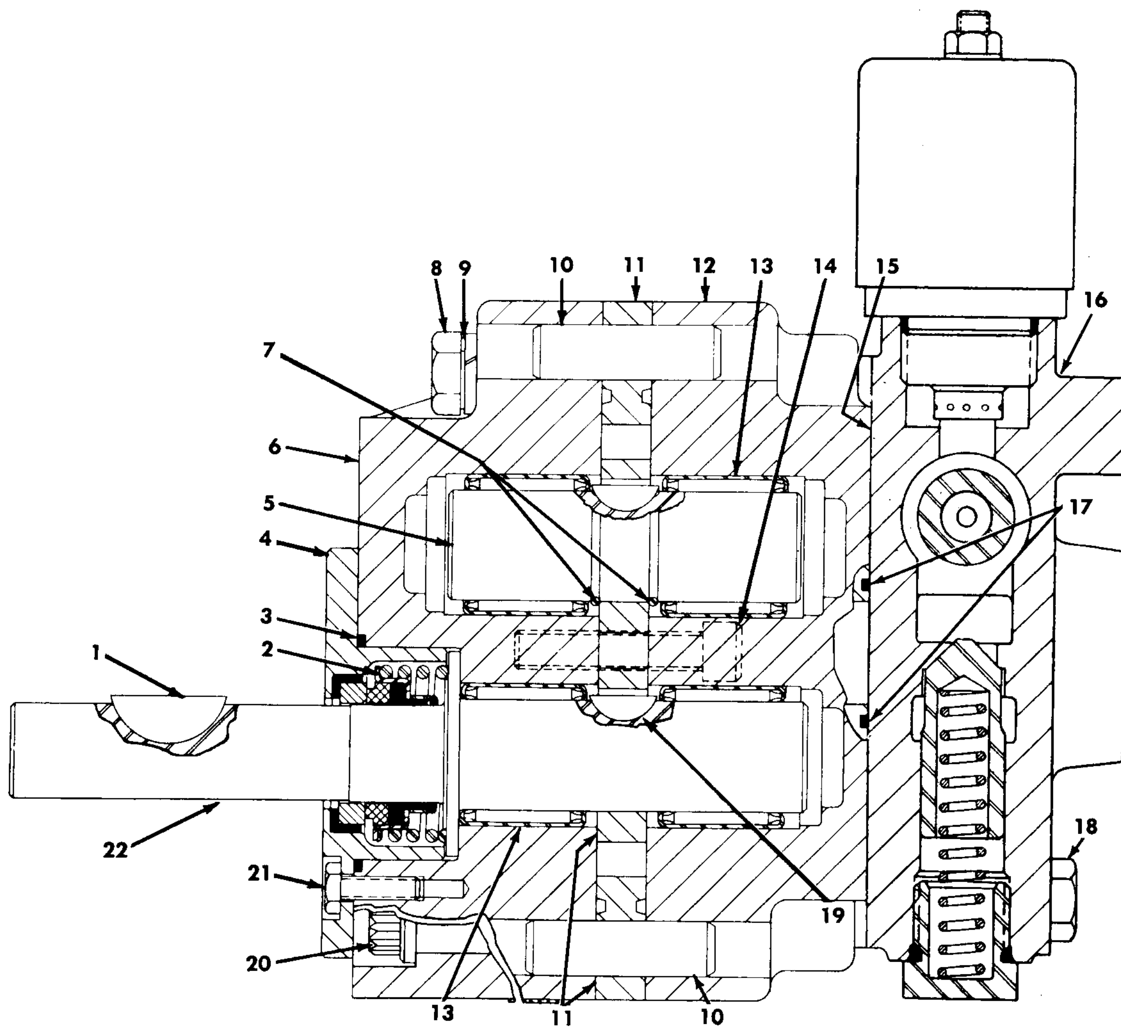
9. Referring to figure 19, place seal seat (2) in gasket (1) and install these two parts in recess in pilot. Lapped surface on seal seat must face outward. Be sure seat gasket is down against bottom of counterbore in pilot (16).

10. IMPORTANT: Check exposed surfaces of drive shaft (15) for burrs and sharp edges. If necessary use polishing stone to smooth edges. Apply light engine oil on exposed end of shaft.

11. Referring to figure 19 for key numbers used in this step, assemble seal parts as follows:

a. Insert friction ring (4) inside of shell (5) so that large lip of friction ring (4) is seated beneath the two lugs in I.D. of shell (5).

b. Slide spring (6) over shell (5) until spring is seated at shoulder on shell.



1 Key
2 Seal Assembly (See Fig. 4)
3 Lathe Cut Washer
4 Pilot
5 Idler Shaft
6 Mounting Housing
7 Retaining Ring
8 Hex-Head Bolt
9 Lock Washer
10 Dowel Pin
11 Gear Spacer Plate (Includes Gear Members)
12 Port Housing Assembly
13 Needle Bearing Assembly
14 Socket Head Cap Screw
15 Shim (Plastic)
16 Valve Block Assembly
17 O-Ring
18 Valve Block Bolt
19 Gear Key
20 12-Point Head Cap Screw
21 Pilot Bolt
22 Drive Shaft

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Figure 20—Sectional View of Fan Drive Motor

c. Lubricate I.D. of friction ring (4) with light engine oil; then place seal face (3) in shell so that two slots on seal face engage two lugs on shell (5). Lubricate seal face with a few drops of engine oil.

d. Install the spring (6), shell (5), friction ring (4), and seal face (3) as an assembly over drive shaft. Use care to keep seal face (3) engaged with lugs in shell (5). Press seal parts down with fingers until spring contacts drive shaft thrust flange.

12. Install lathe cut washer (18) in recess in mounting housing (11). Apply oil on seal face and seal seat, then position pilot (16) with seat and gasket over end of drive shaft and push down all the way. Remove pilot and check friction ring movement. Compress spring by pushing on seal face, then release. Friction ring must slide back with force of spring.

13. Assemble pilot (16) to pump and attach with pilot bolts (12).

14. Install retaining ring (14).

15. Position mounting bracket (17) onto pump assembly and secure with two hex head cap screws and washers.

FAN DRIVE MOTOR OVERHAUL

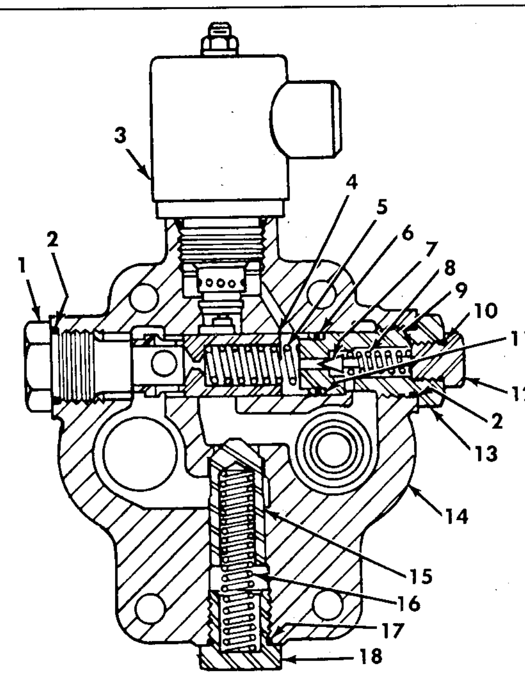
MOTOR DISASSEMBLY

Key numbers in text refer to figure 20, unless otherwise indicated.

1. Remove key (1) from drive shaft (22).
2. Remove bolts (21) which attach pilot (4) to mounting housing (6). Slide pilot with seal seat and gasket out of housing and off end of shaft (22).
3. Remove seal gasket and seal seat (1 and 2, fig. 19) from recess in pilot (4).
4. Using fingers, remove seal face (3, fig. 19) from shaft. Do not use metal tools as the seal face edges may be chipped.
5. Using needle nose pliers, remove shell, friction washer, and spring (4, 5, and 6, fig. 19) from shaft.
6. Remove lathe cut washer (3).
7. Scribe a mark across motor body to assure original positioning of parts when assembling.
8. Remove the four valve block bolts (18), then separate valve block assembly (16) from port housing and remove four plastic shims (15). Remove O-ring (17) from groove in port housing.
9. Loosen the two cap screws (14), four cap screws (8) and lock washers (9), and four counterbore screws (20) which attach the port housing (12) to mounting housing (6).
10. Insert punch in dowel holes of mounting housing (6) and drive out two dowel pins (10).
11. Remove all screws loosened in step 9.
12. Using a soft lead hammer, tap alternately on ears of housings to gradually separate the motor body sections. The port housing assembly (12) must be removed first, then remove the spacer plate and gears (11) with idler shaft (5). Drive shaft (22) cannot be removed from mounting housing (6) until gear key (19) has been removed.

CAUTION: DO NOT ATTEMPT TO PRY SECTIONS OF MOTOR APART AS DAMAGE TO SEALING SURFACES WILL OCCUR. Use care not to nick the lapped surfaces on port housing (12), spacer plate (11), and mounting housing (6).

13. After drive gear has been removed from shaft (22), remove gear key from keyway in shaft and slide drive shaft (22) out through bearing in mounting housing (6).
14. To remove gear from idler shaft (5), remove gear retaining rings (7) from shaft grooves, then slide gear off shaft and remove key.
15. If inspection reveals a need for replacing shaft bearings (13), a suitable puller can be used to remove each bearing assembly from respective



1 Valve Plug	11 Back-up Ring
2 O-Ring	12 Valve Housing Plug
3 Solenoid Valve	13 Valve Housing
4 Dumping Valve Spool	14 Valve Block
5 Dumping Valve Spring	15 Over-running Piston Valve
6 O-Ring	16 Over-running Valve Spring
7 Cone Valve	17 O-Ring
8 Relief Valve Pilot Spring	18 Valve Block Plug
9 Shim	
10 O-Ring	

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Figure 21—Sectional View of Valve Block Assembly

housing bore. Bearings will usually be damaged in the removal operation.

VALVE BLOCK DISASSEMBLY

Key numbers in text refer to figure 21.

1. Remove solenoid valve (12).
2. Remove plug (16), O-ring (7), spring (5), and valve (4). Be careful not to lose shim (17) between spring (5) and plug (16).
3. Remove valve housing (6), O-rings (8 and 10), spring (3), and dumping valve spool (2).
4. Remove plugs (13 and 18), O-rings (8 and 11), spring (15), and piston valve (14).

CLEANING AND INSPECTION

1. Wash all parts in cleaning solvent, and use air hose to remove loose dirt particles from housing cavities.
2. Examine piston (14) and spool (2) (fig. 21) and respective bores in valve block. Neither the pistons nor bores should be scored or excessively worn.
3. Check valve springs which must be in good condition.
4. Examine shaft surfaces which are contacted by bearing rollers. If these surfaces are rough or show evidence of wear, new shafts should be obtained for use when assembling motor. If thrust flange on drive shaft is scored, the drive shaft should be replaced.
5. Inspect all components of drive shaft seal assembly (fig. 19). Use a new seal assembly when assembling motor, if any of the seal parts are found to be defective or damaged.
6. Note condition of spacer plate and gears. If sides of gears are worn or if gear teeth are not in good condition, the spacer plate and gears must be replaced as a matched unit.

IMPORTANT: After inspection, cover all parts to prevent dust or foreign matter from collecting on surfaces. Absolutely no dirt should be permitted on any part to be assembled.

ASSEMBLY OF MOTOR

Key numbers in text refer to figure 20, unless otherwise indicated.

1. If new shaft bearings (13) are being installed, use suitable installer to press new bearings into housing bores. Bearings must be located as shown in figure 20, i.e., far enough into bore so that when motor is assembled, the retaining rings (7) on idler shaft (5) and gear keys (19) will not contact bearing housings.
2. Lubricate drive shaft surfaces with light engine oil, then insert drive shaft (22) through bearing in mounting housing assembly (6), and install gear key (19) in keyway.
3. If gear has been removed from idler shaft (5), install gear key in keyway and install one retaining ring (7). Install gear on idler shaft and install other retaining ring.
4. Support mounting housing and drive shaft assembly with spacer plate side facing upward. Lubricate idler gear and shaft with light weight engine oil, then insert one end of idler shaft into bearing in mounting housing. Install gear on drive shaft with keyway in gear engaged with key (19).
5. Install spacer plate (11) with dowel pins (10) fitting into holes in mounting housing and alignment mark (made when disassembling) indexed with mark on mounting housing (6).
6. Referring to mark made at disassembly, install port housing assembly (12) over ends of shafts (5 and 22) and dowel pins (10).
7. Through port openings in housing (12), install socket head cap screws (14), tightening screws alternately and gradually until motor parts are firmly seated.
8. Install hex-head cap screws (8) with lock washers (9) and install cap screws (20) using 12-point socket wrench. Tighten bolts and cap screws (8 and 20) evenly and firmly.
9. Place gasket and seal seat (1 and 2, fig. 19) in pilot (4) with lapped surface on seal seat facing outward. Be sure seat gasket is down against bottom of counterbore in pilot (4).

10. IMPORTANT: Check exposed surfaces of drive shaft (22) for burrs and sharp edges. If necessary use polishing stone to smooth edges. Apply light engine oil on exposed end of shaft.

11. Referring to figure 19 for key numbers used in this step, assemble seal parts as follows:

a. Insert friction ring (4) inside of shell (5) so that large lip of friction ring (4) is seated beneath the two lugs in I.D. of shell (5).

b. Slide spring (6) over shell (5) until spring is seated at shoulder on shell.

c. Lubricate I.D. of friction ring (4) with light engine oil; then place seal face (3) in shell so that two slots on seal face engage two lugs on shell (5). Lubricate seal face with a few drops of engine oil.

d. Install the spring (6), shell (5), friction ring (4), and seal face (3) as an assembly over drive shaft. Use care to keep seal face (3) engaged with lugs in shell (5). Press seal parts down with fingers until spring contacts drive shaft thrust flange.

12. Install lathe cut washer (3) in recess in mounting housing (6). Apply oil on seal face and seal seat, then position pilot (4) with seat and gasket over end of drive shaft and push down all the way. Remove pilot and check friction ring movement. Compress spring by pushing on seal face, then release. Friction ring must slide back with force of spring.

13. Assemble pilot (4) to motor and attach with pilot bolts (21).

ASSEMBLY OF VALVE BLOCK

Key numbers refer to figure 21.

1. Install valve (14), spring (15) into valve block.
2. Install O-ring (11) on plug (13) and install into valve block.
3. Install O-ring (8) on plug (18) and install into valve block.
4. Install spool (2) and spring (3)
5. Install valve (4), spring (5) into valve housing (6). Install O-ring (7) into plug (16) and install into valve housing (6).
6. Install O-rings (8 and 10) and back-up ring (9) onto valve housing (6). Install valve housing assembly in valve block.
7. Install solenoid valve (12).

NOTE: At this time relief valve setting within valve block can be checked by installing a flat surface plate and gasket to motor side of block, then with a pressure gauge installed into special oil pressure supply line, apply pressure to block inlet port. Note pressure reading when relief valve opens. Relief valve should open at 2000 psi.

INSTALL VALVE BLOCK ON MOTOR

Key numbers refer to figure 20.

With O-rings (17) located in grooves in port housing (12), install valve block assembly (16) to port housing with four valve block bolts (18). Use one plastic shim (15) between valve block and port housing at each bolt (18).

Insert key (1) in motor shaft.

REFRIGERANT COMPRESSOR

The refrigerant compressor, mounted at rear of coach (fig. 22), is a two-cylinder reciprocating type unit. It is self-lubricated and self-contained. The shaft seal is of the rotary type, consisting of a stationary lapped seal face on the seal cover, with a spring-loaded rotating carbon nose ring sealing against the seal face of the stationary cover.

A neoprene seal ring between the carbon nose ring and spring acts as a seal around the shaft. The seal faces are flood-oiled under pressure at all times. A sight glass on the front of the compressor shows the oil level. Shut-off valves are provided at the compressor suction and discharge ports.

Compressor is shaft driven from coach engine by an air-operated clutch. Clutch can be engaged when engine is operating in a range between 3 psi and 15 psi oil pressure. The clutch operation and maintenance information is explained later in this section.

Compressor can be removed from coach with clutch mechanism attached. Removal procedures are explained later under "Compressor Replacement." Compressor overhaul instructions are also explained later under "Refrigerant Compressor Overhaul."

COMPRESSOR OPERATION

The aluminum body of the compressor is divided into three main sections -- the discharge or high pressure gas cavity, the suction or low pressure gas cavity, and the crankcase or housing.

Low pressure refrigerant gas is drawn into the compressor from the suction line. As the refrigerant gas enters the compressor it passes through a fine mesh strainer screen and then into the suction cavity. In the suction cavity, oil entrained with the refrigerant separates from the refrigerant and passes into the crankcase through two check valves. The low pressure refrigerant is drawn into the cylinder during the down-stroke of the piston through the cylinder suction valve which is mounted on the top of the cylinder liner. During the suction stroke of the piston, the cylinder discharge valve in cage on top of cylinder liner is closed. As the piston begins its compression stroke, the cylinder suction valve closes and compression begins. As the piston moves up on the compression stroke, the cylinder discharge valve opens, and the high pressure refrigerant gas passes through the valve into the discharge cavity. The gas then passes through the discharge cavity to the high pressure refrigerant line.

COMPRESSOR MAINTENANCE

Compressor requires practically no maintenance other than making sure that sufficient (but not too much) oil and refrigerant is maintained in the system at all times. The lubrication system of the compressor will fail if the system loses its charge of oil or refrigerant. Both oil and refrigerant must be circulating through the compressor whenever it is running to prevent very serious damage. Check compressor mounting bolts periodically. Check carefully for indication of oil or refrigerant leakage. Leakage should be remedied promptly to prevent excessive refrigerant and oil loss. If necessary, compressor can be overhauled as explained later under "Refrigerant Compressor Overhaul."

COMPRESSOR LUBRICATION

The compressor crankcase serves as a reservoir for the main oil charge. A portion of the

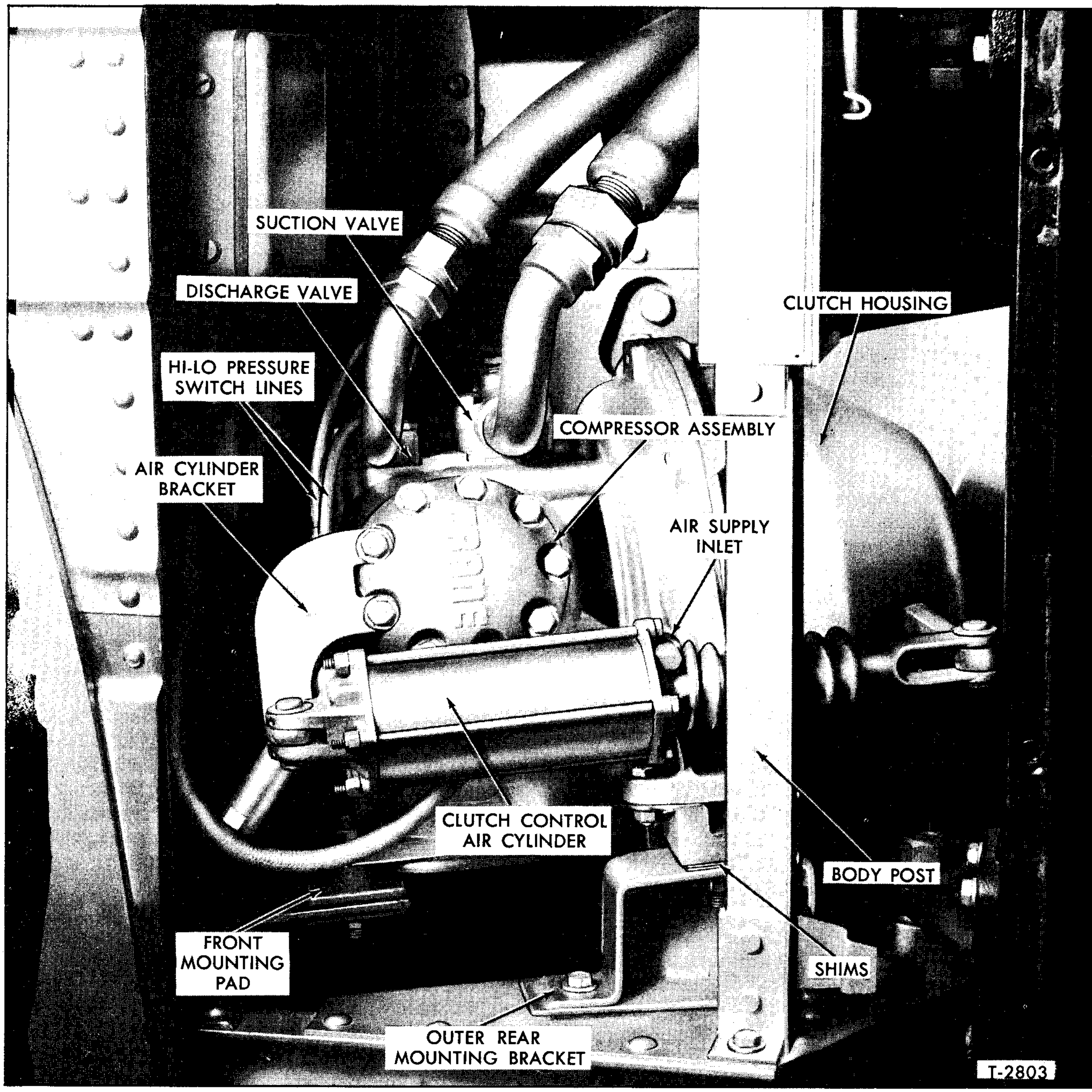


Figure 22—Air Conditioning Compressor Installed

lubricating oil circulates with the refrigerant, and this oil is separated from the refrigerant as the refrigerant passes through the suction cavity of the compressor. As the low pressure refrigerant and oil separate in the suction chamber, the oil goes to the bottom of the chamber, and the gas goes to the top of the chamber. The oil passes from the suction chamber to the crankcase through two check valves in the crankcase wall. Check valves allow oil to flow into the crankcase from the suction cavity, but check against the flow of oil out of the crankcase.

During the "OFF" cycle of the compressor, refrigerant tends to collect and condense in the crankcase. The liquid refrigerant mixes with the oil in the crankcase. When the compressor begins to operate, there is a rapid reduction of pressure in the crankcase above the oil level. This permits the liquid refrigerant to evaporate out of the oil. As the refrigerant boils off and leaves the crank-

case, the oil tends to foam and leave with the refrigerant.

Compressor lubrication is accomplished by a force feed, direct drive, positive displacement pump, which is mounted to the end of the crankshaft. Oil from the crankcase is drawn into the pump through a tube which connects the pump to a fine mesh strainer located in the sump of the crankcase. This strainer scavenges oil from the bottom of the crankcase and prevents the entrance of foreign particles into the oil circulating system.

Pump forces oil into discharge end main bearing after which it enters end of crankshaft. Crankshaft oil passages are arranged to feed from inside of crankshaft throw. Two magnetic plugs in crankshaft oil passages trap steel particles. Oil escapes between rod bearings and is converted into mist to lubricate wrist pins and cylinder walls. Oil flows from drive end of crankshaft into crankshaft seal chamber.

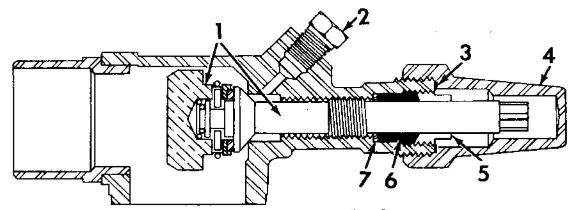
It is highly important that only the recommended refrigeration compressor oils which contain a de-foamant be used in this compressor. The approved oils for use in this compressor are listed at end of this section. These oils can be obtained locally through refrigeration equipment suppliers. Oil should be purchased in sealed cans only. Never use bulk oil or oil which has been exposed to air.

IMPORTANT: USE ONLY APPROVED COMPRESSOR OILS.

The initial charge of oil in the compressor is approximately 4-2/3 pints. After the compressor has been operated for about 30 minutes at engine idle speed, and engine has obtained normal operating temperature, the oil level should be about 1/2 way up on the sight glass. If oil is near or below the bottom of the sight glass, oil should be added. The oil level should always be checked with the compressor operating. Before adding oil, first determine and correct cause of loss of oil. A new compressor or one having been overhauled should be drained and refilled after the first 200 hours of operation. Refer to "Servicing Compressor Oil Charge" in "SYSTEM SERVICES AND TESTS" Section.

COMPRESSOR SHUT-OFF VALVES

Double-seating shut-off valves (fig. 23) are provided at the compressor discharge and suction ports. With both valve stems turned all the way in (clockwise - closed), compressor is isolated from the rest of the system. "Open Position" of valves, frequently referred to in this section, is with the valve stem in the full back-seated position as shown



1 Valve and Stem Assembly
2 Test Gauge Connection
3 Cap Gasket
4 Cap
5 Packing Gland
6 Packing
7 Packing Washer

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Figure 23—Compressor Refrigerant Valve (Typical)

in figure 23, then turned 1/4 to 1/2 turn off backseated position.

IMPORTANT: Valve stem caps with gaskets must be in place and tight at all times during system operation.

COMPRESSOR STORAGE

If compressor is removed from coach and is to remain in storage (less the clutch unit), stand the compressor on end, drive end down, on blocks in such a way that no weight rests on the compressor shaft.

COMPRESSOR REPLACEMENT

Compressor is removed from coach with the clutch assembly attached. Before removing compressor, pump down the system as directed under "Pumping Down the System" in "SYSTEM SERVICES AND TESTS" section.

REMOVAL (Fig. 22)

IMPORTANT: Closure plates shown in figure 24 are used to cover the valve ports and should be made available before beginning to remove compressor.

1. Position rear wheels of coach on four to six-inch run-up blocks. This is not absolutely necessary, but will provide easier access for making lower disconnections.
2. Remove stone shield from below compressor compartment.
3. Disconnect clutch control cylinder air line, then temporarily apply shop air pressure (65 psi or more) to cylinder.
4. Remove cylinder push rod yoke pin from yoke and clutch release fork. Remove two bolts which attach air cylinder bracket to compressor cylinder head. Remove air cylinder from compressor and replace bolts in cylinder head of compressor.
5. Remove caps from suction and discharge

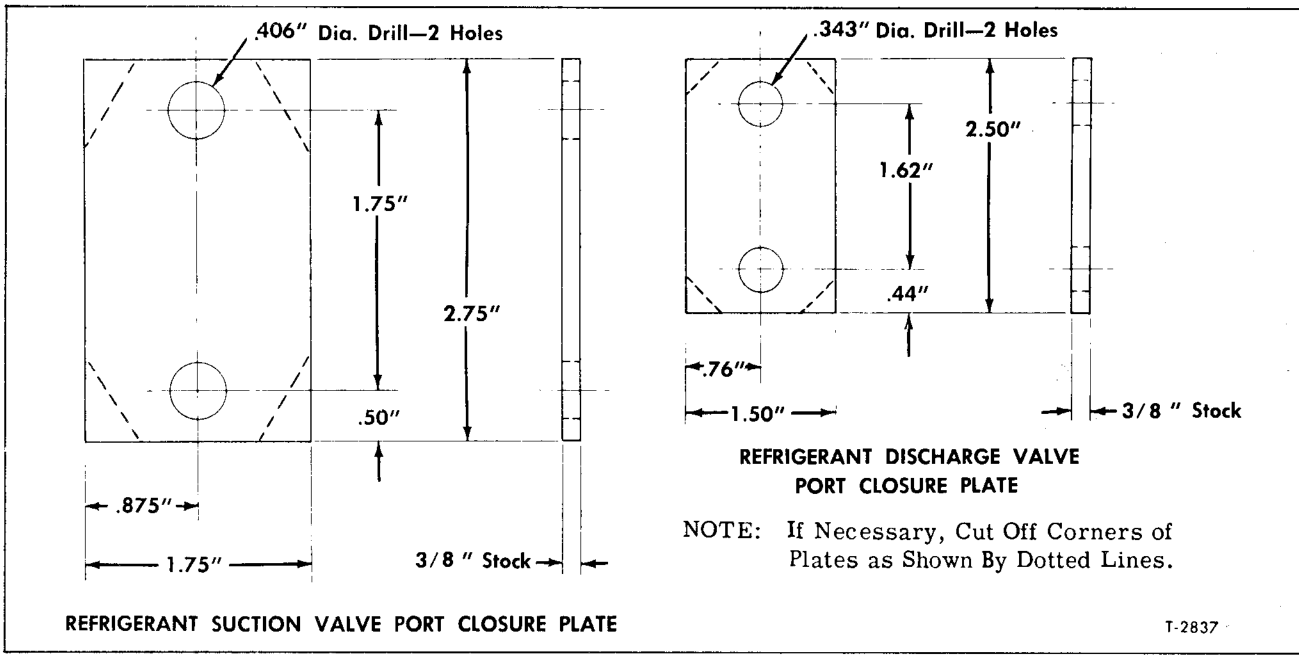


Figure 24—Closure Plates For Sealing Compressor Valve Ports

valve on the top of compressor. Turn valve stems all the way in (clockwise-closed) to isolate compressor from system.

6. Slowly loosen bolts which attach valves to compressor. Remove valves and tie freon tubes with attached valves clear of compressor.

7. Immediately after removing valves, install closure plates with gaskets over compressor valve openings. Plates shown in figure 24 can be improvised locally.

8. Disconnect HI-LO pressure switch hoses at compressor fittings (fig. 25). Cap the connections and tie hoses clear of compressor.

9. Remove two bolts which attach upper and lower end of body post to body at rear of compressor. Remove post.

10. Remove four bolts which attach outer and inner mounting brackets at rear of compressor to coach body.

11. Remove two nuts and bolts attaching front compressor mounting pad to support plate.

12. Disconnect drive shaft at accessory drive flange and remove driveshaft.

13. Lift compressor and remove from coach with rear mounting brackets attached. Note and record number of shims used at rear mounts. Support compressor in manner whereby weight is not supported on clutch release fork.

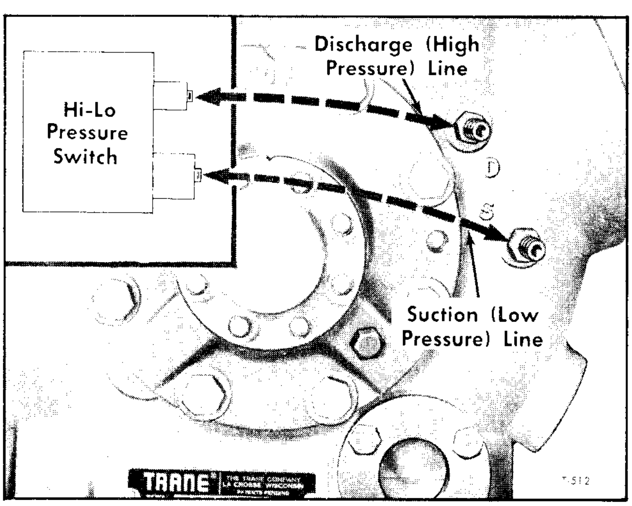


Figure 25—Hi-Lo Pressure Switch Line Connections

INSTALLATION (Figure 22)

1. Before installing compressor, examine compressor rear rubber mountings. If mounting rubber sections are deteriorated or collapsed they should be replaced.

2. Attach rubber mounts, shims, and mounting brackets to compressor. See figure 27 for cross section of compressor mountings. Place compressor into compartment.

3. Install four bolts with spacers which attach inner and outer rear brackets to body and handtighten with spacers and spacer plates positioned as shown in figure 27, install front mounting bolts, washers, and nuts and handtighten.

4. IMPORTANT: Mounting holes in compressor support plates are oversized so compressor can be aligned when installing in coach. An alignment tool (fig. 26) must be used to align compressor properly. Tool can be fabricated locally from

dimensions and specifications called out in figure 28.

5. Slip narrow end of tool over clutch spline. Rotate tool so that flat on flange end of tool which is inscribed "TOP" is located at top. Extend flange end until stops (detail 2 and 4, figure 28) can be inserted.

6. Crank engine until two opposing holes in accessory drive flange are vertical. Insert locating pins on tool into flange.

7. Move compressor toward accessory drive until end of spline rests against stop in tool.

8. Compressor should then be positioned until a consistent space of 0.060" exists between accessory drive flange and alignment tool flange.

9. Alignment of compressor to proper drive angle should generally be accomplished by positioning compressor in oversized mounting holes. However, rear mounting shims may have to be added or removed (fig. 27) if any of the mounting components have been replaced.

10. When compressor is properly aligned, tighten all mounting bolts and remove alignment tool.

11. Insert driveshaft into clutch spline and attach to accessory drive flange.

12. Remove closure plates from ports of compressor. Being careful not to allow dirt to enter ports, attach refrigerant valves to compressor, using new gaskets. Tighten attaching bolts evenly and firmly.

13. Connect HI-LO pressure line to compressor fitting. Tighten connection firmly.

14. Install clutch control air cylinder by removing two compressor head bolts and attaching

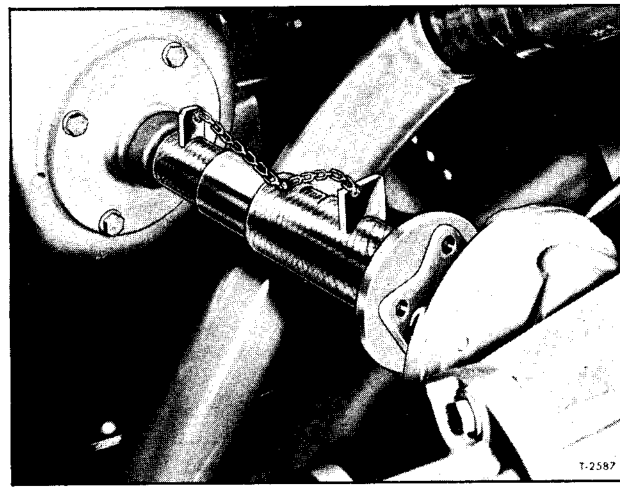


Figure 26—Compressor Alignment Tool Installed

bracket. Temporarily apply shop air pressure (65 psi or more) to clutch control air cylinder. Make clutch linkage adjustment and secure release fork to cylinder push rod yoke as directed later under "Compressor Drive Maintenance."

15. Connect clutch control air cylinder air line.

16. Install body post to side of coach. Tighten bolts firmly.

17. Accomplish services outlined later under "Refrigerant Valves," "Purging The System," "Testing For Leaks," and "Checking For Air In The System," all in "SYSTEM SERVICES AND TESTS" section.

18. Install stone shield below compressor.

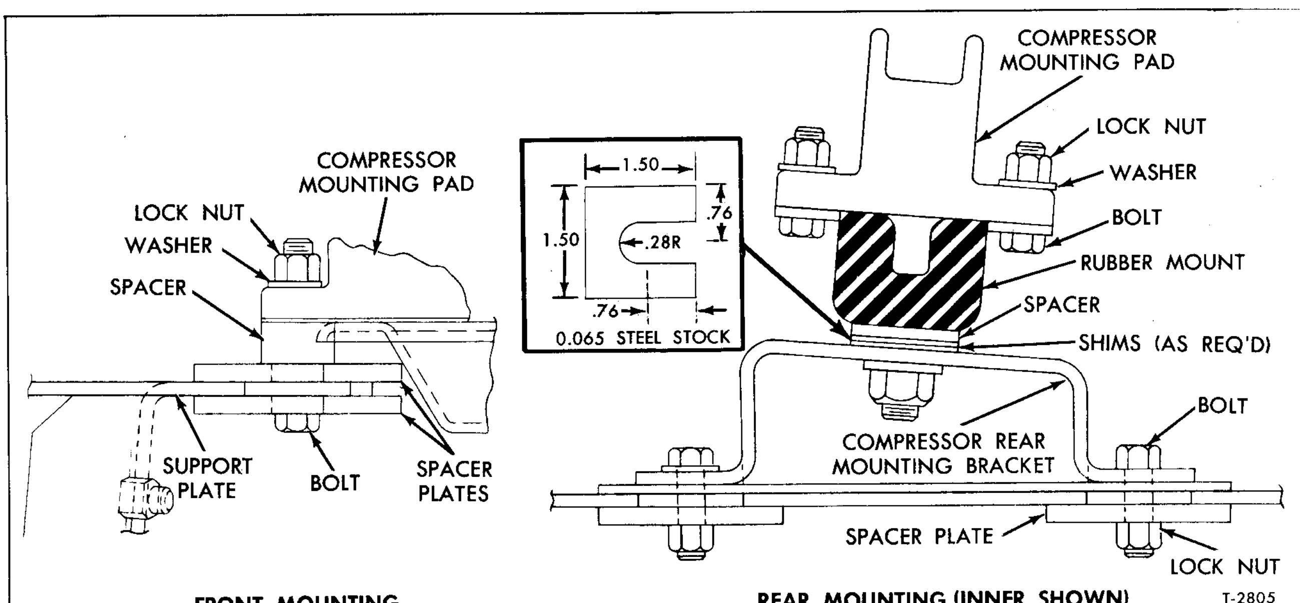
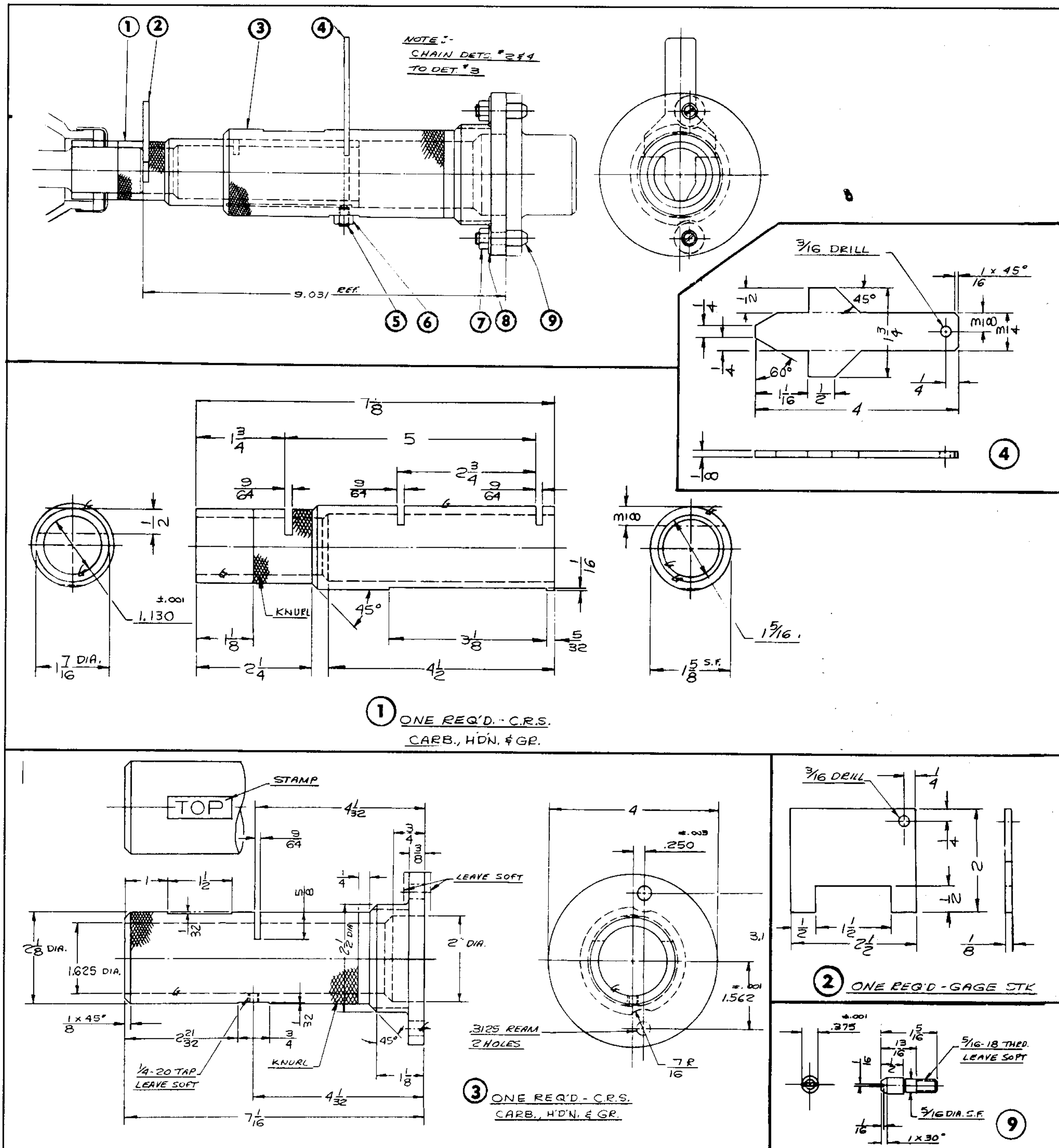


Figure 27—Compressor Mounting and Shim Details



DETAIL NO.	QTY.	STOCK SIZE	MATERIAL	DETAIL NO.	QTY.	STOCK SIZE	MATERIAL
1	1	1¾ dia. x 7¼ lg.	C.R.S.	6	1	¼-20 hex nut	Std.
2	1	⅛ x 2 x 2⅝	Gage Stock	7	2	5/16-18 hex nut	Std.
3	1	4" dia. x 7 3/16 lg.	C.R.S.	8	2	5/16 plain washer	Std.
4	1	⅛ x 1¾ x 4⅛	Gage Stock	9	2	½ dia. x 1 7/16 lg.	C.R.S.
5	1	¼-20 x ½ half dogpoint set screw	Std.				

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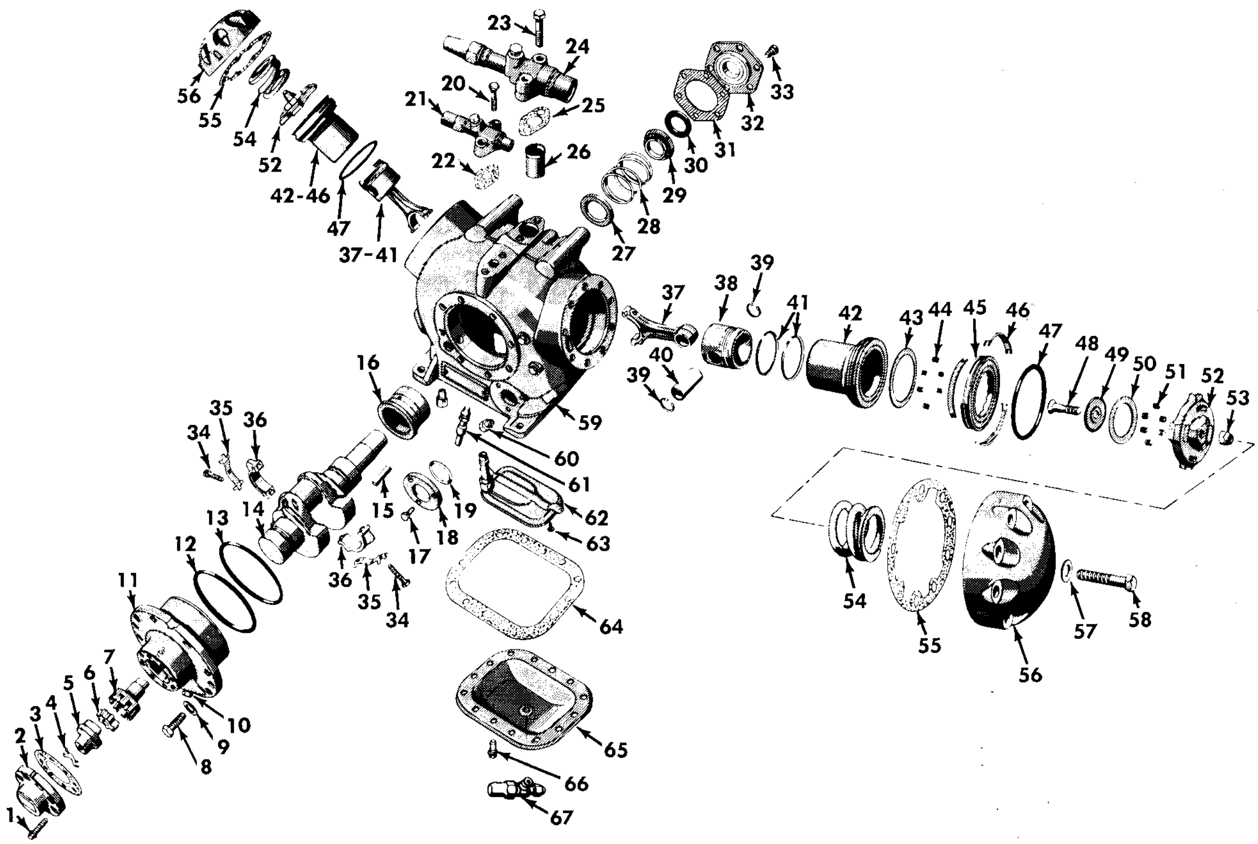
Figure 28—Compressor Alignment Tool Details



1 Screw (1/4"-20 x 3/4")
2 Oil Pump Cover
3 Gasket (.013" or .015")
4 Spring
5 Oil Pump Rotor
6 Oil Pump Idler Gear
7 Oil Pump Carrier
8 Bolt (3/8"-16 x 1")
9 Flat Washer
10 Plug
11 Bearing Head
12 O-ring
13 O-ring
14 Crankshaft
15 Drive Key
16 Bearing
17 Bolt (1/4"-20 x 5/8")
18 Sight Glass Assembly
19 O-ring
20 Bolt (5/16"-18 x 2")
21 Discharge Valve Assembly
22 Gasket
23 Bolt (1/2"-13 x 2")
24 Suction Valve Assembly
25 Gasket
26 Refrigerant Strainer
27 Spring Retainer
28 Seal Spring
29 Neoprene Seal
30 Carbon Nose Ring
31 Gasket (O-ring on Early Units)
32 Seal Cover
33 Bolt (3/8"-16 x 3/4")
34 Bolt
35 Lock Strap
36 Cap
37 Connecting Rod
38 Piston
39 Snap Rings
40 Piston Pin
41 Piston Rings
42 Cylinder Liner
43 Suction Valve
44 Suction Valve Springs
45 Valve Plate
46 Retaining Rings
47 O-ring
48 Valve Cage Bolt
49 Discharge Valve Seat
50 Discharge Valve
51 Discharge Valve Springs
52 Valve Cage
53 Lock Nut
54 Safety Head Spring
55 Gasket
56 Cylinder Head
57 Flat Washer
58 Bolt (3/8"-16 x 1-3/4")
59 Compressor Housing
60 Oil Check Valve Assembly
61 Oil Relief Valve Assembly
62 Oil Strainer Assembly
63 Screw (No. 10-24 x 1/2")
64 Gasket
65 Handhole Cover
66 Screw (3/8"-16 x 3/4")
67 Compressor Oil Charging Valve

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Figure 29—Refrigerant Compressor Components

REFRIGERANT COMPRESSOR OVERHAUL

Before overhauling compressor (fig. 29), the system must be pumped down and the unit removed from coach. Procedures for removing compressor are explained previously under "Compressor Replacement."

> **IMPORTANT**
>
> The immediate area in which the compressor is to be overhauled should be dust-free, and if pieces of cloth are to be used for the cleaning of parts, they should be lint-free.

When servicing parts of compressor, handle the parts carefully and protect them against rusting immediately upon removal from compressor housing. Before installing parts, wash with refrigeration compressor parts cleaner, then oil with new (clean) compressor oil. This applies especially to seal and bearing surfaces to prevent seizure when unit is first put in operation. Use new O-ring seals and gaskets at build-up of compressor.

The design of compressor permits the replacement of many components and sub-assemblies without having to disassemble balance of compressor. For example, the cylinder liner can be replaced without having to remove piston and rod. However, the overhaul procedures described herein covers the complete disassembly of compressor in logical sequence and to the extent recommended by the manufacturer.

NOTE: When overhauling compressor, refer to "Compressor Wear Rate Table" under "Specifications" at end of this section.

COMPRESSOR DISASSEMBLY

NOTE: Drain the oil from compressor crankcase by opening valve (67, fig. 29) at bottom of compressor handhole cover.

SUCTION AND DISCHARGE VALVE REMOVAL

Key numbers in text refer to figure 29.

NOTE: These two valve assemblies may have been removed previously when compressor was removed from coach. If not, remove as follows:

1. Remove two bolts which attach each refrigerant valve assembly (21 and 24) to compressor. Remove valves and valve gaskets (22 and 25).
2. Remove strainer screen assembly (26) from the suction valve port as shown in figure 30.

CYLINDER HEAD AND DISCHARGE VALVE REMOVAL AND DISASSEMBLY

Key numbers in text refer to figure 29.

1. Remove all but two opposed cylinder head attaching bolts. Back off remaining bolts two or three full turns (fig. 31).

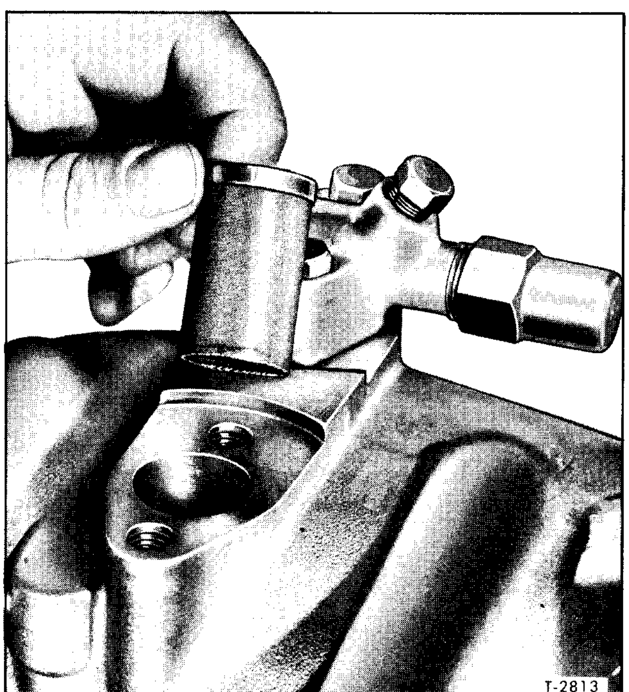


Figure 30—Removing Strainer Screen Assembly

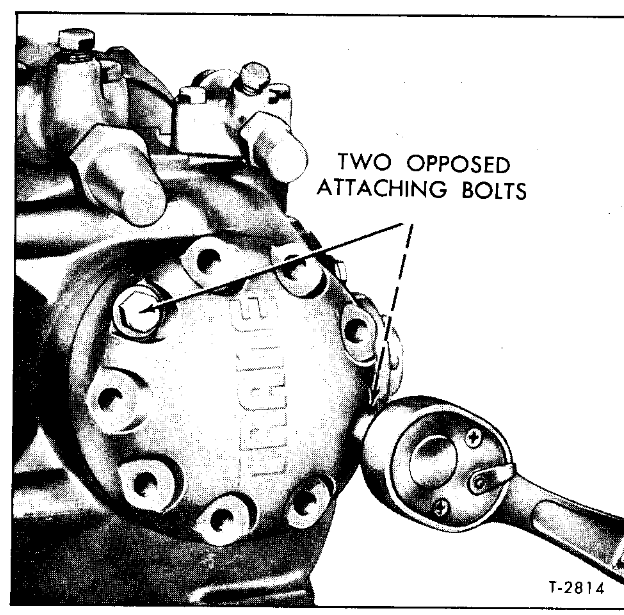


Figure 31—Removing Cylinder Head Cover

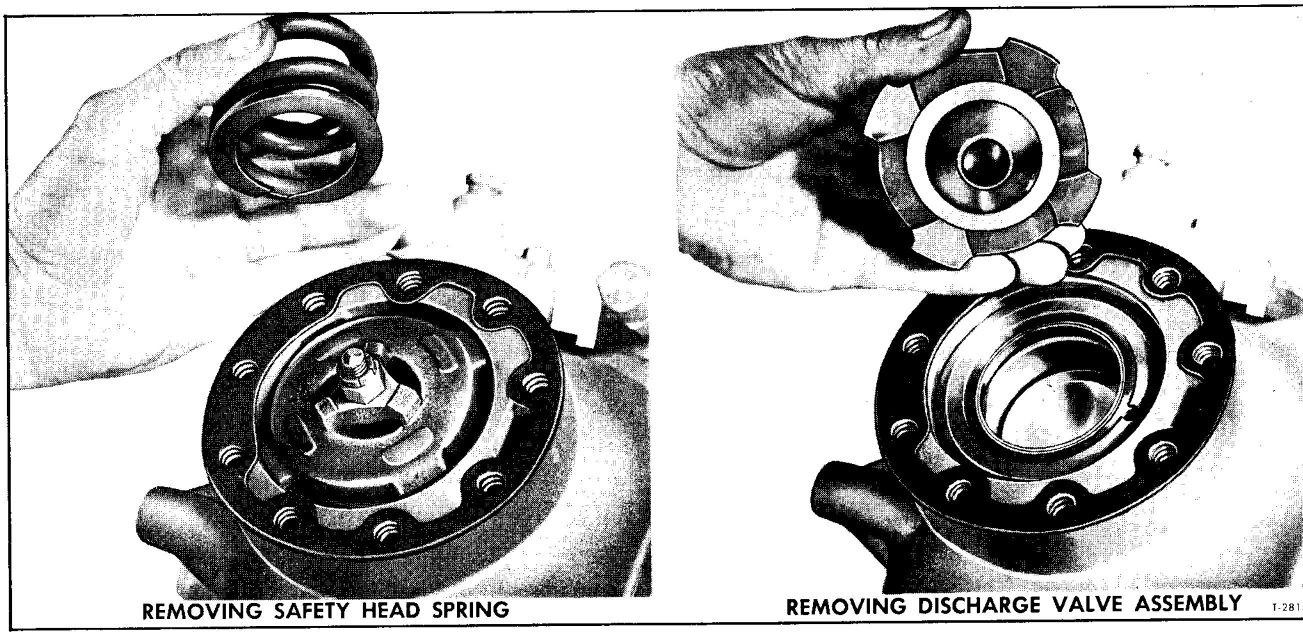


Figure 32—Removing Safety Head Spring and Discharge Valve Assembly

2. Examine cylinder head (56) to see if head is following heads of attaching bolts as shown. If not, tap the head with a plastic hammer until head gasket (55) breaks loose.
3. Slowly and alternately remove two remaining cylinder head bolts, then remove head. Lift off safety head spring (54) and remove head gasket (55) (fig. 32).
4. Lift discharge valve assembly from compressor (fig. 32).
5. Remove lock nut (53) from discharge valve bolt (48). Remove bolt and valve seat (49). Separate discharge valve ring (50) and six springs (51) from discharge valve cage (52).

HANDHOLE COVER AND OIL STRAINER REMOVAL

Key numbers in text refer to figure 29.

NOTE: If the cylinder liner only is to be removed, it will not be necessary to remove handhole cover (65).

1. Remove cover attaching bolts. If necessary, tap the cover with soft hammer to loosen. Remove cover and cover gasket (64).
2. Remove two screws (63) which attach oil strainer (62) to crankcase (fig. 34).
3. Disconnect strainer tube fitting at line elbow. Remove oil strainer.

CYLINDER LINER, PISTON, AND CONNECTING ROD REMOVAL

NOTE: The cylinder liner can be removed from compressor without removing the piston and connecting rod. See following steps 1, 2, and 3.

Key numbers in text refer to figure 29.

1. The suction valve plate (45) is tapered inward at the top. A block of wood, plastic, or soft metal should be improvised to dimensions shown in figure 33 to fit into this taper.
2. Rotate the crankshaft until piston head is down about two inches from top, then place the block into cylinder. Rotate crankshaft to cause piston (38) to press block and cylinder liner (42) from compressor bore (fig. 33).

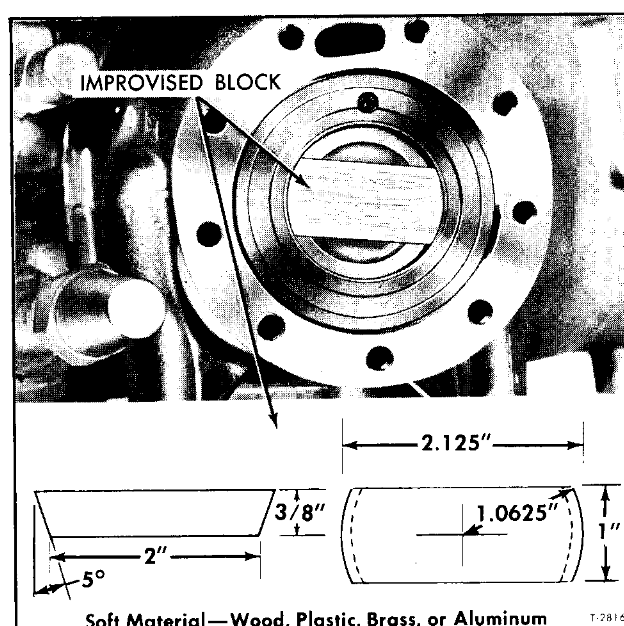


Figure 33—Using Improvised Block to Remove Suction Valve and Liner

AIR CONDITIONING

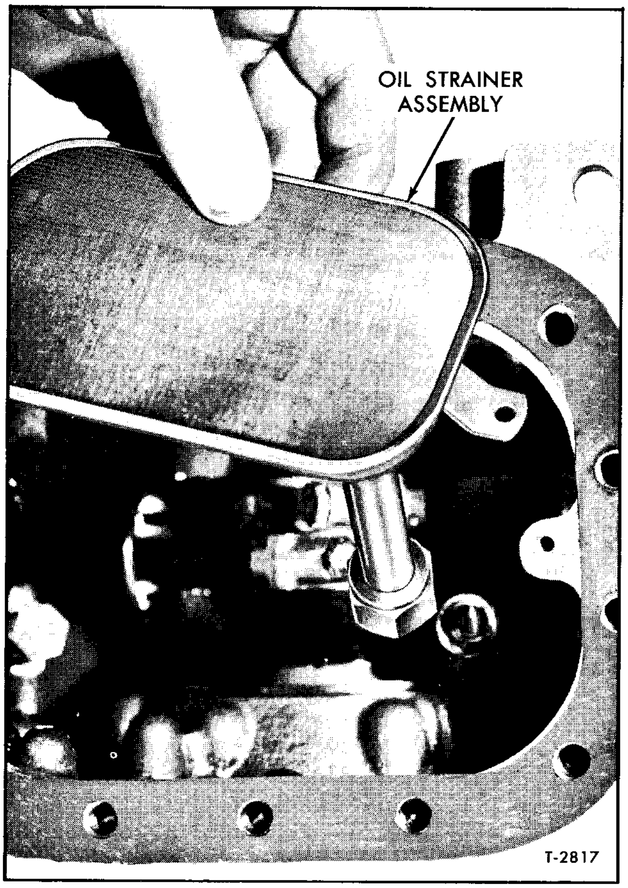


Figure 34—Removing Crankcase Oil Strainer Assembly

CAUTION

DO NOT BUMP PISTON AGAINST BLOCK; USE AN EVEN PRESSURE.

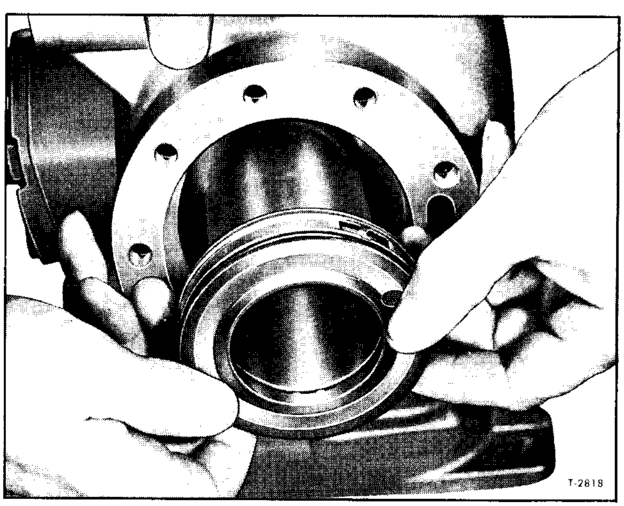


Figure 35—Pulling Liner Off Piston

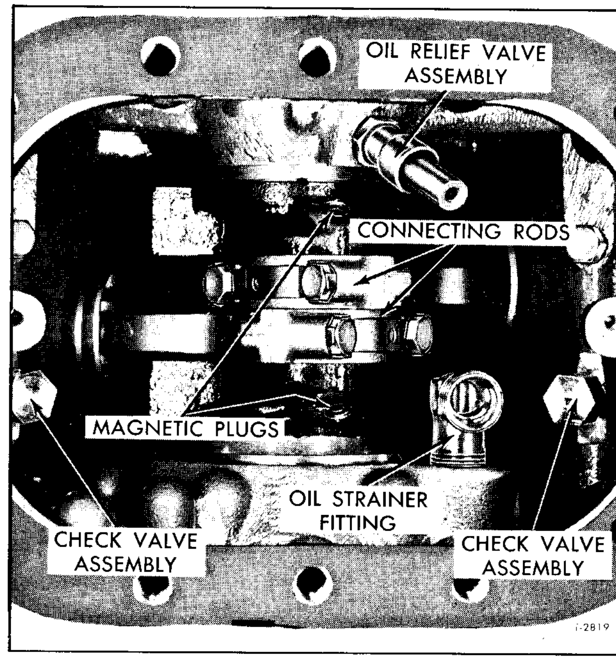


Figure 36—Connecting Rod, Cap, and Bolts Installed

NOTE: If piston cannot be used to force liner out, a tapped hole in block (if metal) for the use of a puller bolt can be used for pulling liner.

3. Make sure liner is forced out beyond the O-ring seal (44), then withdraw liner by hand (fig. 35). Support the piston through the liner so that piston does not bump against the compressor housing when the liner comes off piston.

IMPORTANT: Before removing other cylinder liner unit, the related piston and connecting rod should be removed from unit. Damage to the piston and piston rings will occur if crankshaft is rotated during removal of remaining liner unit.

4. To remove liner, piston, and connecting rod as a complete assembly, rotate crankshaft

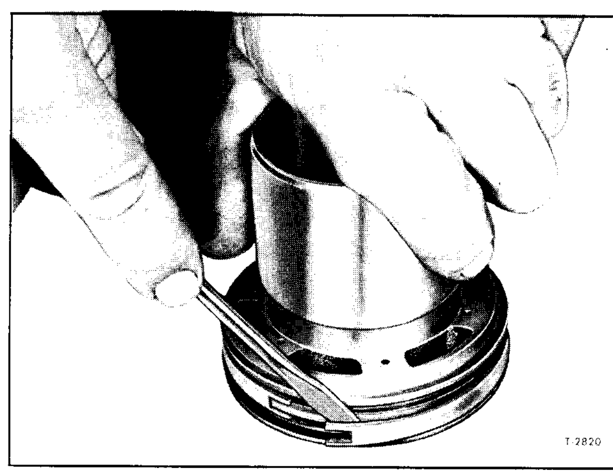


Figure 37—Removing Suction Valve Retaining Rings

(14) until connecting rod cap bolts are accessible through the handhole cover opening. Oil strainer (62) must be removed (fig. 30). Open the tabs of connecting rod bolt lock strap (35) as shown in figure 36, then remove cap bolts. Remove the cap from bottom of connecting rod. Being very careful, pull liner with piston and rod from the cylinder bore. Pull liner from piston.

IMPORTANT: Keep all liner, piston, and rod assemblies separate and mark them in relation to bore from which they were removed.

CYLINDER LINER AND SUCTION VALVE DISASSEMBLY

Key numbers in text refer to figure 29.

NOTE: The suction valve assembly is secured to the liner by three 120 degree retainers (46).

1. Invert the liner and valve assembly and pry the retainers outward (fig. 37).

IMPORTANT: DO NOT MOVE THE LINER AROUND ON TOP OF THE VALVE ASSEMBLY.

2. Lift the liner away from the valve assembly and remove the suction valve (43) as shown in figure 38. Remove valve springs (44) and O-ring (47) from valve plate (45).

NOTE: Until time of assembly, keep valve plate with related liner as a matched set.

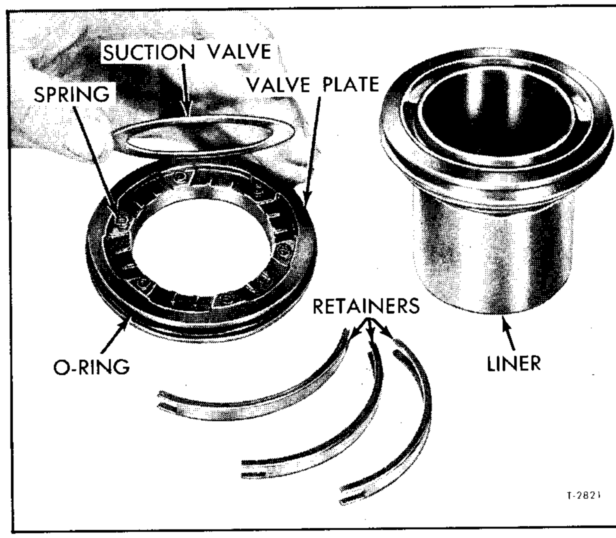


Figure 38—Removing Suction Valve Components

PISTON AND CONNECTING ROD DISASSEMBLY

Key numbers in text refer to figure 29.

1. If rings (41) are to be reused, they can be removed from piston using thin shim stock inserted between rings and piston. Carefully work rings out of groove and slide them over the shim stock and off piston.

2. Using Tru-Arc pliers, remove snap rings (39) from ends of piston pin. Drive pin from piston

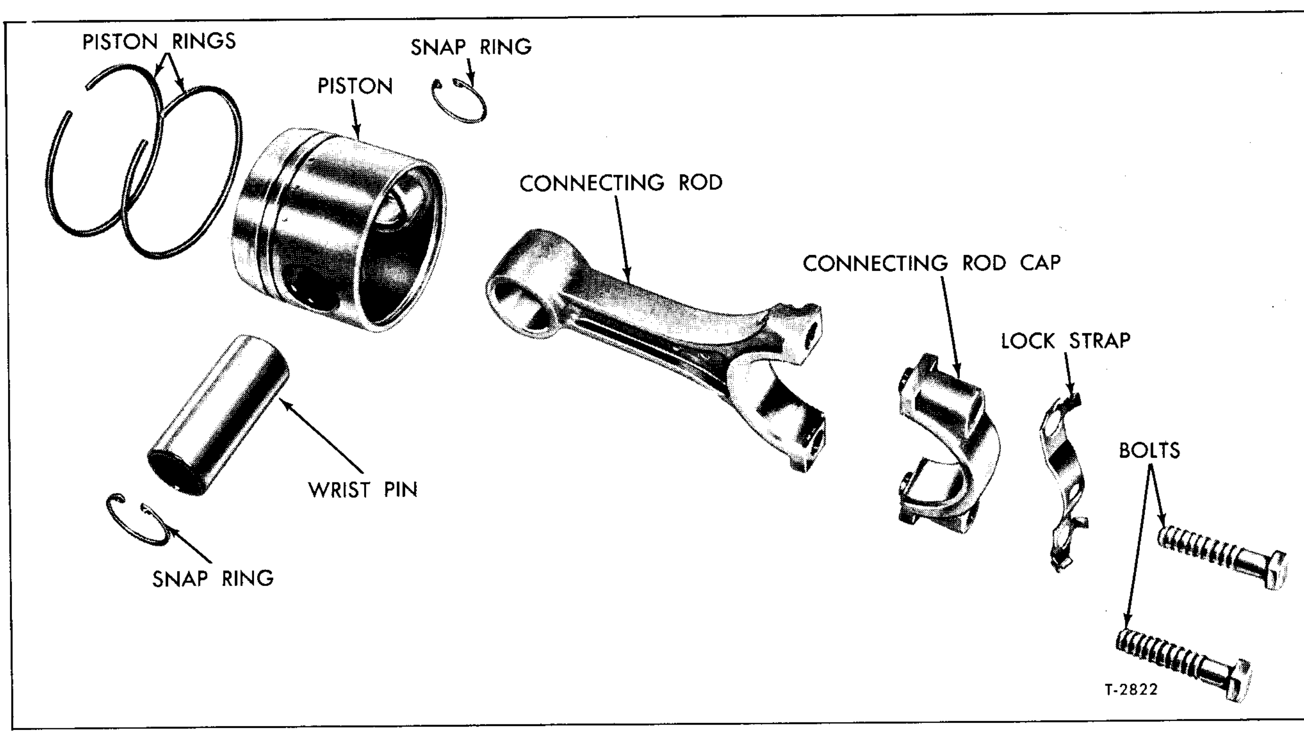


Figure 39—Piston and Connecting Rod Components

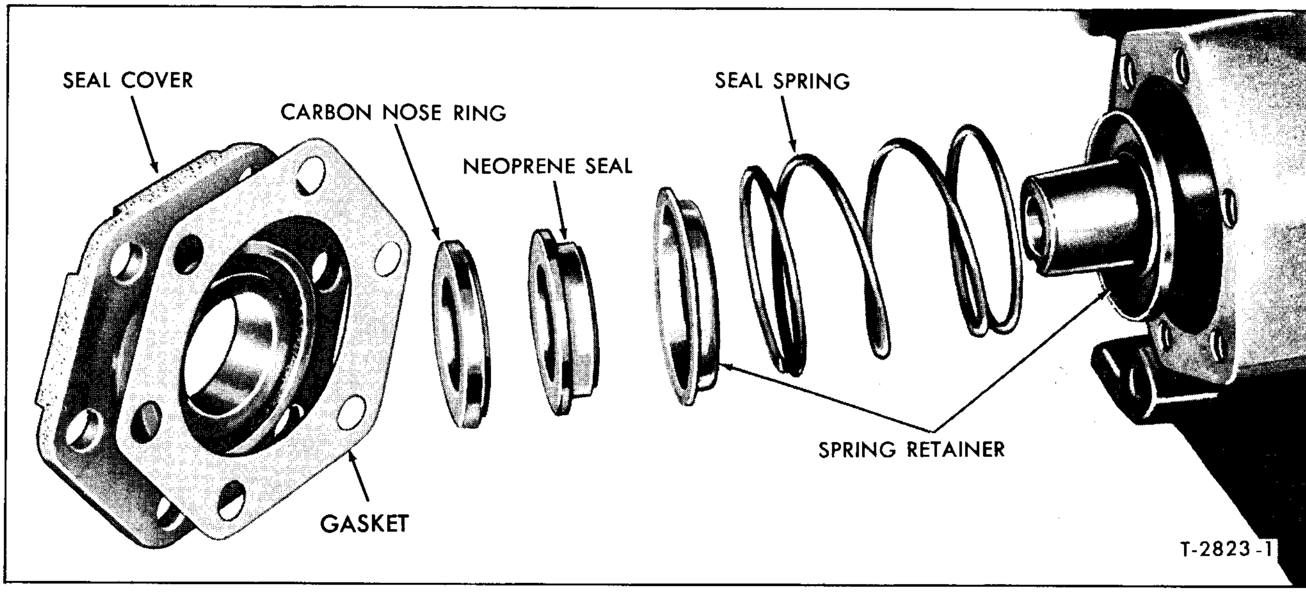


Figure 40—Replacing Shaft Seal Components

using a soft driving rod. Use care not to nick piston surface or distort piston pin hole. Figure 39 shows piston and rod components.

COMPRESSOR SHAFT SEAL REMOVAL

Key numbers in text refer to figure 29. Also refer to figure 40.

1. Loosen and remove all but two opposite cap screws (33) which attach seal cover to housing. Slowly and alternately back out the remaining two cap screws. Seal cover should be forced away from housing by tension of shaft seal spring (fig. 40). However, if cover does not follow the two cap screws, tap rim of cover lightly with plastic hammer to free cover from housing. Carefully back out the two cap screws.

IMPORTANT: Be sure that cover is removed evenly so as not to distort seal and cause breakage of carbon ring within seal.

2. When the seal cover has been removed, the seal components (carbon nose ring, neoprene ring, steel retainers, and spring) can usually be pulled from crankshaft (fig. 40). In some cases, the neoprene ring will adhere to shaft. It can be loosened by using a seal puller or by hooking short ends of two Allen-type wrenches behind ring and pulling ring from shaft.

IMPORTANT: Use extreme care in the handling and stowing of seal components. The carbon nose ring can be easily broken.

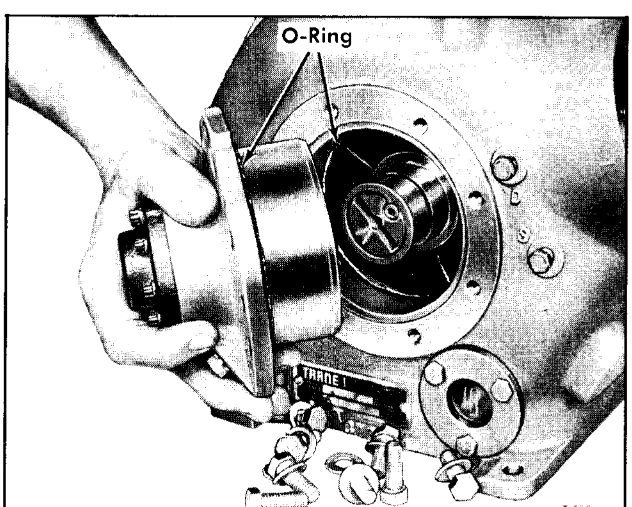


Figure 41—Replacing Head and Oil Pump

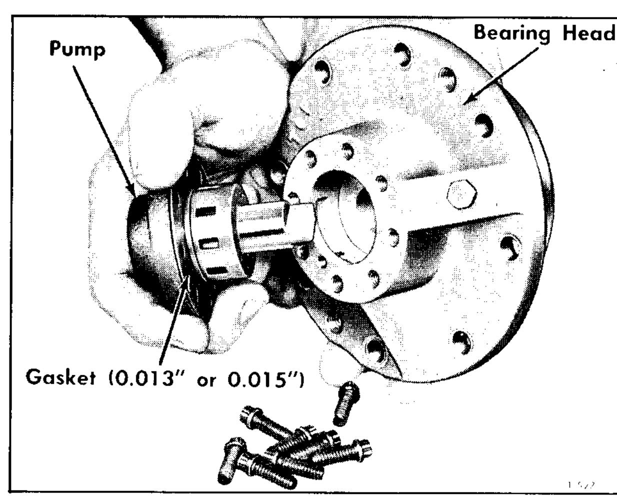


Figure 42—Oil Pump Separated From Head

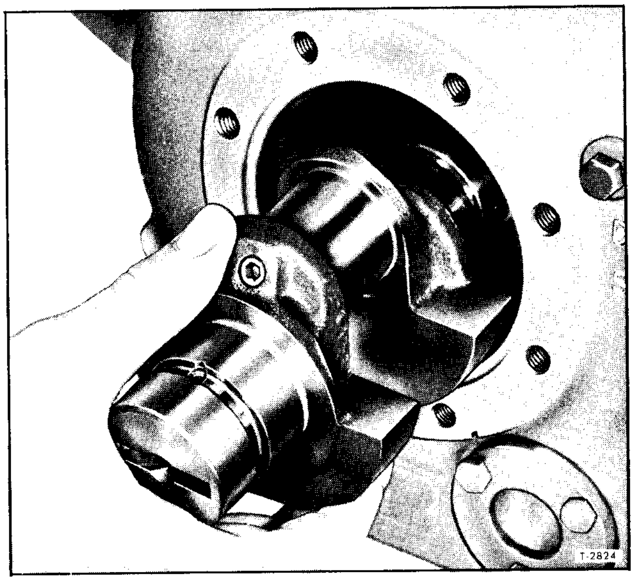


Figure 43—Replacing Crankshaft

PUMP END BEARING HEAD AND
OIL PUMP REMOVAL

Key numbers in text refer to figure 29.

1. Remove screws which attach bearing head (11) to housing. Pull head and oil pump assembly from housing (fig. 41).

NOTE: Two jack-screw holes are provided in bearing head flange. When removing head, tighten jack-screws evenly. If the crankshaft is seized within the bearing head, support the crankshaft through the handhole opening as the assembly is removed.

2. Remove O-rings (12 and 13) from the compressor bearing head and compressor housing.
3. Remove screws which attach oil pump to bearing head. Jar the pump assembly to break the gasket seal (fig. 42). Remove gasket (3).

NOTE: Pump can be disassembled and cleaned if desired.

CRANKSHAFT AND BEARING REMOVAL

Key numbers in text refer to figure 29.

1. The crankshaft (14) is removed through the bearing head opening. Grip the crankshaft at the end and through the handhole openings, slide the crankshaft out of the seal end bearing and out of housing (fig. 43).
2. Pull the seal end bearing (16) toward the pump-end of the housing to remove (fig. 44).

HOUSING OIL RELIEF VALVE AND
CHECK VALVE REMOVAL

NOTE: Valves are shown installed in figure 36.

1. Remove two check valves (60, fig. 29) within the housing.
2. Remove the oil relief valve (61, fig. 29) from housing.

NOTE: Valves can be disassembled, cleaned, and replaced as necessary.

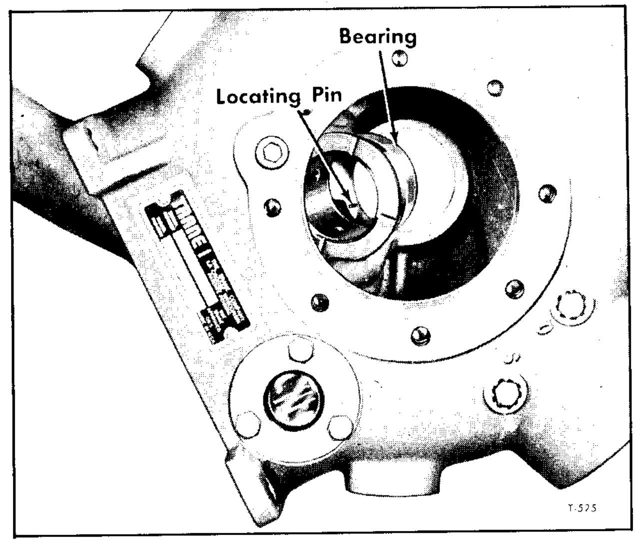


Figure 44—Replacing Seal End Bearing

CLEANING AND INSPECTION

CLEANING

1. Clean all compressor components with refrigeration compressor parts cleaner. DO NOT USE CARBON TETRACHLORIDE. Use a stiff bristle brush if necessary to loosen foreign particles. Direct air through all passages in castings and into both ends of all check and relief valves.
2. Scrape all gasket flange surfaces to make sure all gasket and sealing material is removed.

CAUTION: Do not gouge flange surfaces while scraping.

INSPECTION

Key numbers in text refer to figure 29.

1. Inspect compressor housing (59) and other

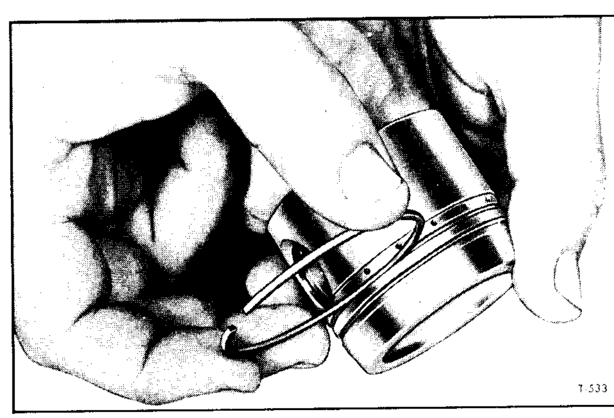


Figure 45—Checking Piston Ring Groove Clearance

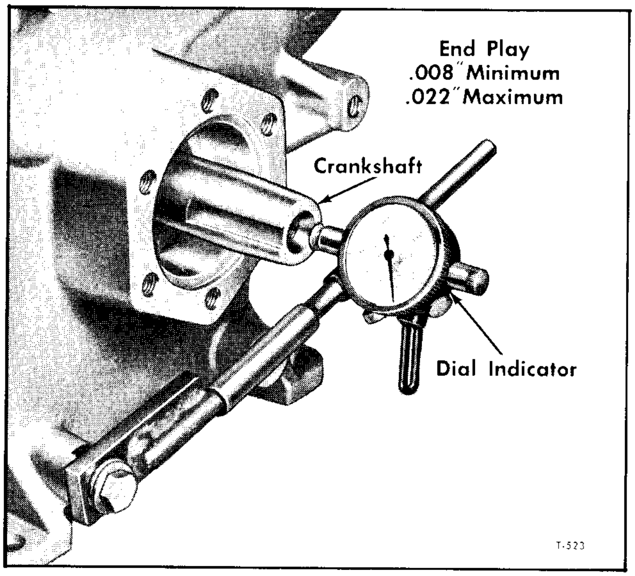


Figure 46—Checking Crankshaft End Play (Typical)

tapped components for crossed threads and any other damage.

2. Examine valve surfaces of cylinder suction and discharge valve components. Replace small valve springs (44 and 51) if compressor has operated more than 3000 hours.

3. Inspect pistons (38) for scoring, cracks, or damage of any kind.

4. Check fit of rings (41) in piston ring grooves. Use back edge of ring to check fit (fig. 45). Rings should move freely in piston grooves.

5. Examine crankshaft seal components for excessive wear or damage. If components are found in good condition they can be reused. If damaged, replace with complete new seal assembly.

6. Check components of compressor for wear to dimensions shown on "Compressor Wear Rate Table" at the end of this section.

7. Examine the crankshaft journals, bearing surfaces and seal end bearing (16) for wear. Remove plugs from crankshaft. Clean plugs, blow out passages in crankshaft, then replace plugs.

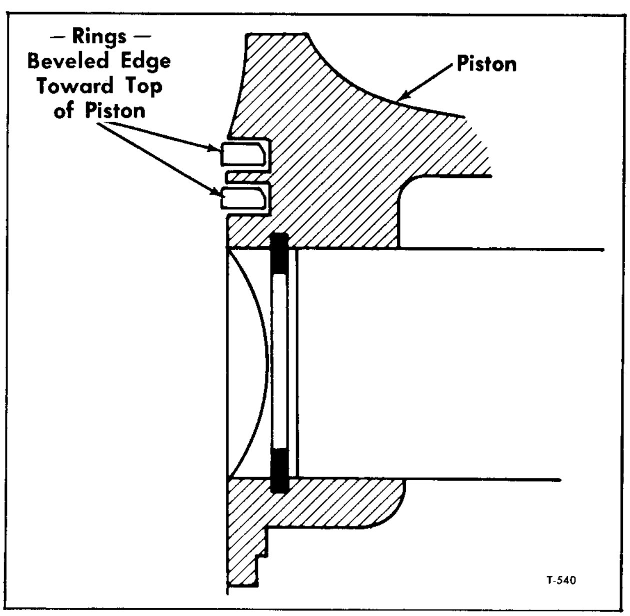


Figure 47—Ring Position in Piston

COMPRESSOR BUILD-UP

Before building up compressor, coat all components with clean compressor oil. This will provide initial lubrication and prevent rusting.

> **IMPORTANT**
>
> Use new O-ring seals and gaskets when assembling compressor.

HOUSING OIL RELIEF VALVE AND CHECK VALVE INSTALLATION

Key numbers in text refer to figure 29.

Referring to figure 36, install oil relief valve (61) and two oil check valves (60) as shown. Tighten valves firmly.

CRANKSHAFT AND BEARING INSTALLATION

Key numbers in text refer to figure 29.

1. Insert the seal end bearing (16) into position with hole in bearing located over locator pins as shown in figure 44.

2. Guide the crankshaft (14) into housing and into end bearing. Reach through the handhole opening to support the crankshaft.

3. Install the pump end bearing head (11) and check crankshaft end play with a feeler gauge or dial indicator.

IMPORTANT: Be sure to torque the bearing head attaching screws to 20 foot-pounds to obtain the correct end play reading. End play should be between 0.008" and 0.022". Figure 46 shows procedure using dial indicator. Move crankshaft endwise when making check.

NOTE: If a feeler gauge is used, measure the clearance between the shoulders of crankshaft and both end bearings. When using this method, measure around the crankshaft at several points to account for any burrs which may be present.

PUMP END BEARING HEAD AND OIL PUMP INSTALLATION

Key numbers in text refer to figure 29.

1. When a new oil pump is to be installed, the following procedure is necessary since the bushing in the bearing head is removable and must be re-

moved and a new bushing installed. The clearance between the oil pump gear and end cap must be set as follows:

a. Insert the new bushing in the bearing head. Attach oil pump to bearing head (fig. 42) using a 0.013" gasket (3).

b. Tighten attaching screws to 6 ft.-lbs. torque.

c. Remove pump and replace 0.013" gasket with a 0.015" gasket.

2. Lubricate gasket (3), then install pump and tighten attaching screws to 6 ft.-lbs. torque.

NOTE: Make sure holes in gasket are aligned with related holes in pump and head.

3. Clean and lubricate the bearing surfaces of the crankshaft and bearing head (11).

4. Insert one O-ring (13) into groove of compressor housing and other O-ring (12) on the bearing head next to flange as shown in figure 41.

5. Slide the bearing head into the housing. Rotate head until oil pump key aligns with slot in end of crankshaft, then locate "Top" on bearing head in position and install attaching bolts. Tighten bolts to 20 foot-pounds torque.

COMPRESSOR SHAFT SEAL INSTALLATION

NOTE: Refer to figure 40 when installing seal components.

1. Lubricate the seal surfaces of crankshaft with clean compressor oil.

2. Slide the seal spring assembly onto end of crankshaft as far as it will go, then wet the carbon nose ring with clean compressor oil and fit into spring retainer ring.

NOTE: The notches in the carbon nose ring must be aligned with the tabs on the retaining ring.

3. Clean the face of seal cover and the housing where seal cover mounts. Place seal cover with gasket (O-ring on early units) against the housing (push, if necessary, to contact the seal spring), insert two bolts on opposite sides and tighten hand tight. Insert the remaining attaching bolts. Tighten bolts evenly to 20 foot-pounds torque.

ASSEMBLY OF PISTON, RINGS, AND CONNECTING ROD

Key numbers in text refer to figure 29.

1. Position connecting rod (37) in piston (38). Drive piston pin through piston and rod using a hammer and soft driver. Install pin snap rings (39) using Tru-Arc pliers.

2. Work rings (41) carefully over top of piston to their respective grooves, using shim stock to aid in moving rings into position. NOTE: Chamfer on rings should always be on top as shown in figure 47. Check for freeness of rings in grooves after installing.

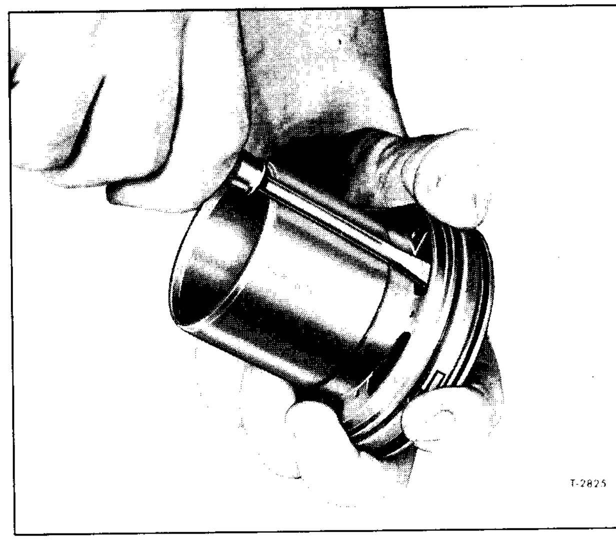


Figure 48—Checking Suction Valve Movement

ASSEMBLY OF SUCTION VALVE AND LINER

Key numbers in text refer to figure 29.

1. Place the O-ring (47) into outer groove of valve plate (45). Figure 38 shows O-ring installed.

2. Place six small valve springs (44) into position in valve plate, then place suction valve (43) over springs as shown in figure 38.

3. Set the liner down over the suction valve assembly and install the three 120 degree retainers (46).

4. Work the suction valve (43) to make sure it is not restricted or pinched within the assembly (fig. 48).

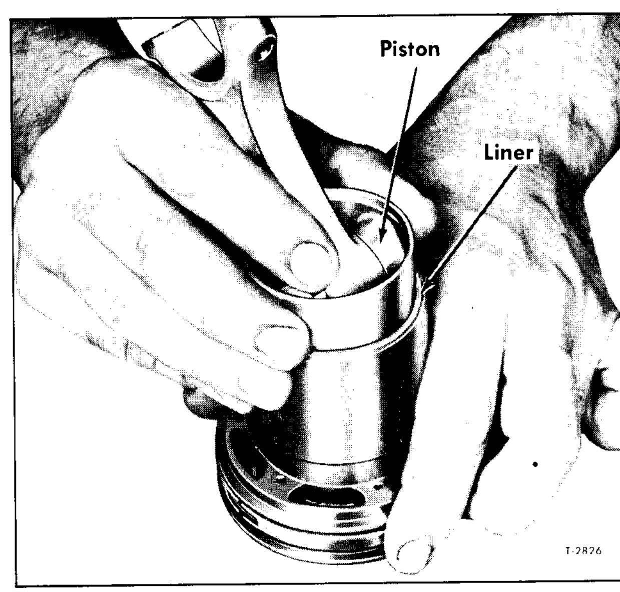


Figure 49—Installing Piston Assembly in Liner

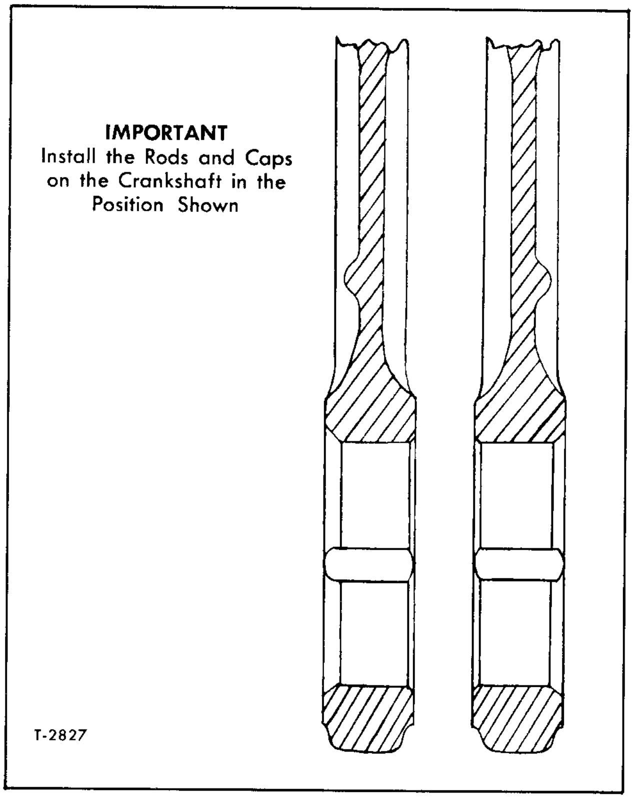


Figure 50—Matching Connecting Rods

INSTALLATION OF CONNECTING ROD, PISTON, AND LINER

NOTE: Clean the bearing surfaces of the connecting rod, rod cap, and the crankshaft, then lubricate with clean compressor oil.

1. Invert the cylinder liner and suction valve assembly on a soft surface. Stagger the piston ring gaps.

2. Work the piston head and rings down into the liner with a rocking motion (fig. 49).

NOTE: The inside edge of liner skirt is tapered to assist the entry of piston and rings.

3. After both rings have entered the liner, push the piston down until top of piston is even with top of suction valve plate.

NOTE: To match and install connecting rod and cap properly, refer to figure 50.

4. Rotate the crankshaft until the journal is in position below the cylinder opening. Guide the rod by reaching through the handhole cover opening and make sure it seats properly on the crankshaft.

5. Press the liner and suction valve assembly all the way into cylinder opening, then place the rod cap in position (chamfer to fillet) and install rod bolts and a NEW lockstrap (35). Tighten bolts to 6 foot-pounds torque, then bend up tabs of lockstrap against heads of bolts.

IMPORTANT: After tightening rod bolts, rotate the crankshaft to be sure the rod is free. Repeat as each rod is installed.

CAUTION: Overtightening of bolts will distort cap.

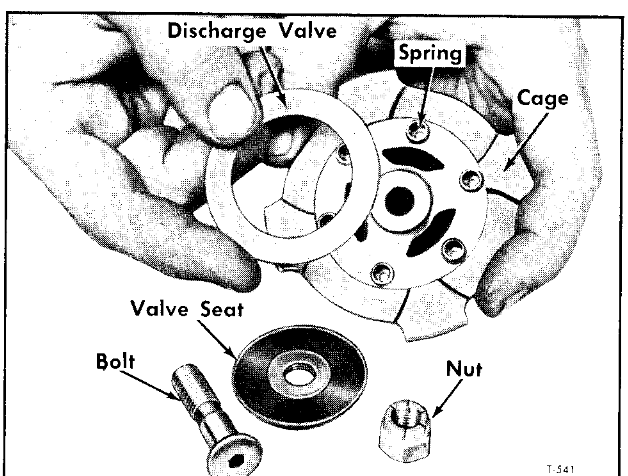


Figure 51—Installing Discharge Valve Components

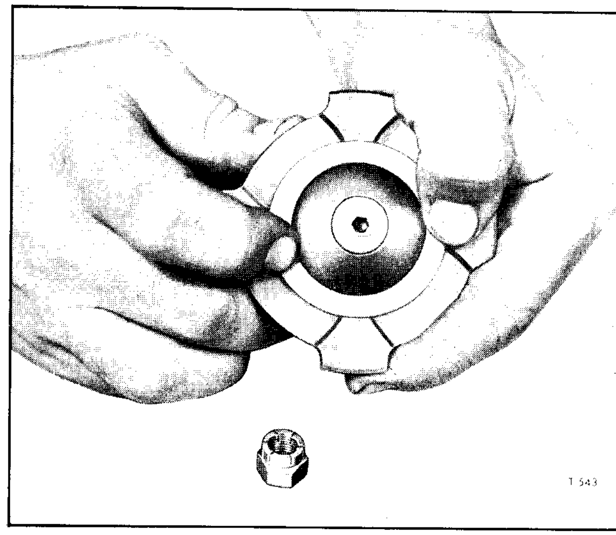


Figure 52—Checking Discharge Valve Movement

ASSEMBLY OF DISCHARGE VALVE COMPONENTS

Key numbers in text refer to figure 29.

Figure 51 shows valve components being installed.

1. Place the valve springs (51) into valve cage (52) and lay the valve ring (50) over the top of the springs. Insert the valve seat (49) and bolt (48).

2. Work the valve ring up and down to make sure it is free to move as shown in figure 52.

3. Attach lock nut (53) and tighten to 23 foot-pounds torque.

DISCHARGE VALVE AND CYLINDER HEAD INSTALLATION

Key numbers in text refer to figure 29.

1. Place the discharge valve assembly over piston (fig. 32).

2. Center the safety head spring (54) on the discharge valve assembly as shown in figure 32.

3. Insert two bolts (58) with washers on opposite sides of cylinder head (56). Apply clean compressor oil to head gasket (55) then place gasket on the head using bolts as a guide.

4. Place the head, with two bolts and washers, over the cylinder and start bolts (two or three turns). Inspect the safety head spring (54) to be sure it is positioned properly.

5. Tighten both head bolts alternately to draw the head down evenly. Insert remaining bolts and washers. Tighten all the bolts to 20 foot-pounds torque.

OIL STRAINER INSTALLATION

1. Connect the strainer tube loosely to elbow in compressor housing.

2. Attach strainer mounting brackets to compressor housing with two screws.

3. Final tighten strainer tube connection.

HANDHOLE COVER UNIT ASSEMBLY AND INSTALLATION

Key numbers in text refer to figure 29.

Apply clean compressor oil to handhole cover gasket (64), then install gasket and handhole cover (65) to housing. Install attaching bolts (66) finger tight, then tighten bolts evenly to 20 foot-pounds torque.

REFRIGERANT STRAINER SCREEN, SUCTION, AND DISCHARGE VALVE INSTALLATION

Key numbers in text refer to figure 29.

1. Insert oil strainer screen assembly (26) down into suction valve port (fig. 30).

2. Using new valve gaskets (22 and 25), install bolts attaching suction and discharge valves. Tighten discharge valve bolts to 20 foot-pounds torque and the suction valve bolts to 28 foot-pounds torque.

COMPRESSOR DRIVE

Compressor, mounted in coach as shown in figures 22 and 53, is driven through an air-operated disc clutch which is mounted to drive end of compressor. Clutch is propeller shaft driven from accessory drive unit mounted to front end of coach engine.

Clutch is engaged by air pressure admitted through an electrically-operated air valve, (fig. 7). Air pressure from solenoid valve to the clutch air cylinder is supplied through a flexible air line.

When air pressure is applied to clutch cylinder the clutch is engaged. When air pressure is exhausted from cylinder, clutch becomes disengaged. Spring within clutch removes the pressure from clutch plate.

Procedures for removing and overhauling the clutch assembly are explained later under "Compressor Drive Clutch." Overhaul procedure of clutch assembly is also explained later under "Compressor Drive Clutch."

COMPRESSOR DRIVE OPERATION

With "HEAT-AIR COND." switch on control panel at left of driver placed in "AIR COND." position, and with the engine oil pressure being less than 15 psi and the pressure in coach air system at 65 psi or more, the clutch control solenoid valve becomes energized. With solenoid valve operating coil energized, air pressure is admitted to clutch air cylinder through the flexible line which releases pressure from clutch cover spring, causing clutch to become engaged. Lower view of figure 57 shows clutch in the engaged position, air pressure applied. The upper view of figure 57 shows disassembled components of clutch.

Schematic Wiring Diagram for electric circuits is shown in back of this manual.

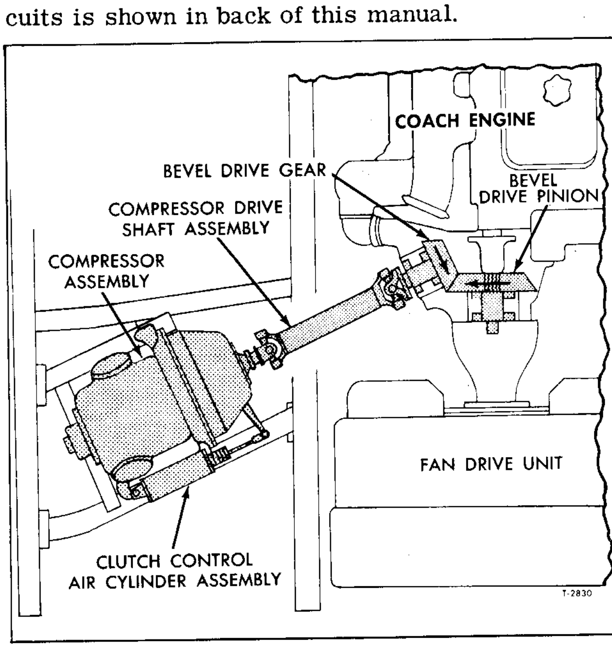


Figure 53—Compressor Drive Shaft and Accessory Drive Layout (Typical)

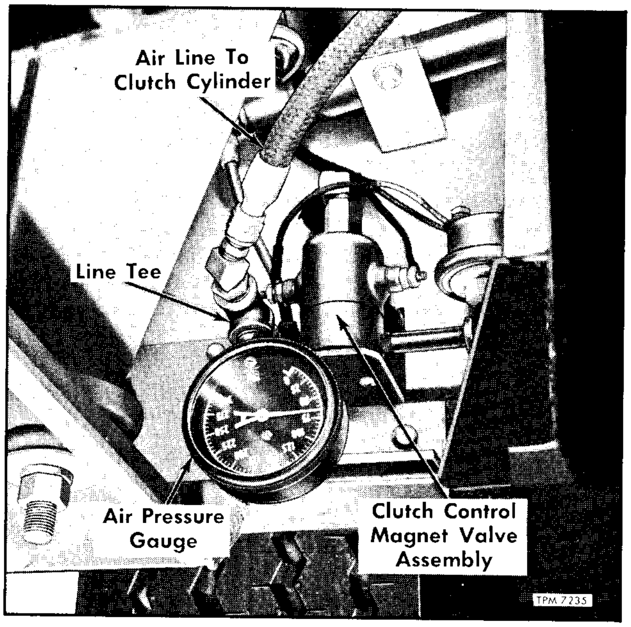


Figure 54—Clutch Control Air Pressure Check (Typical)

COMPRESSOR DRIVE MAINTENANCE

The following instructions apply to items which require periodic inspection and adjustment. Maintenance information on compressor drive propeller shaft, accessory drive clutch, and clutch control air cylinder is explained later under respective headings.

Inspect clutch drive components, making sure clutch housing bolts and drive shaft universal joint flange bolts and nuts are tight.

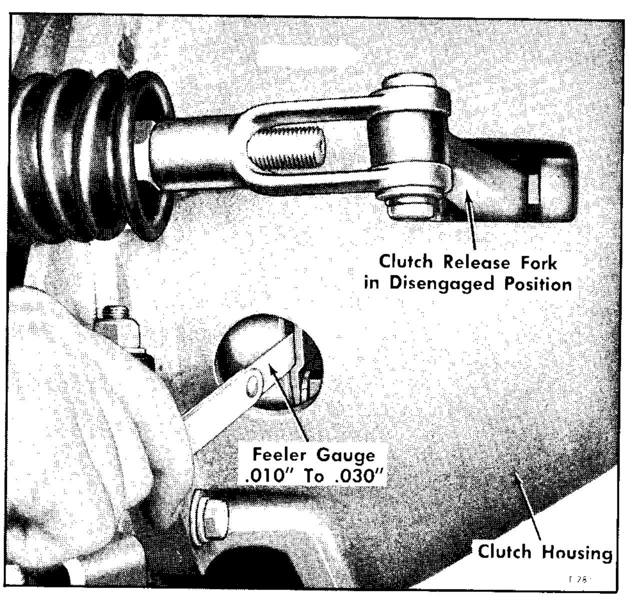


Figure 55—Checking Clutch Drive Plate Clearance

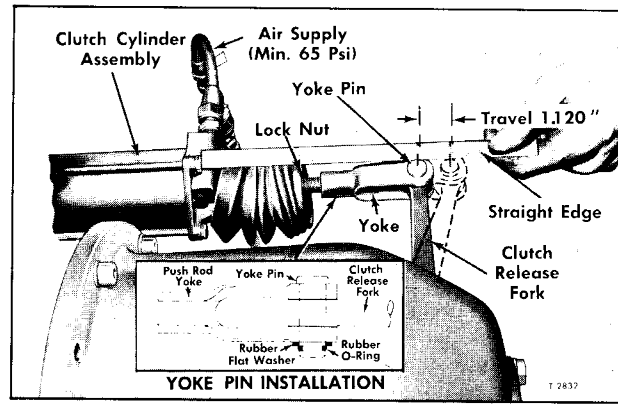


Figure 56—Piston Rod Yoke Adjustment

CLUTCH CONTROL AIR PRESSURE CHECK

In manner shown in figure 54, check the air pressure to clutch control cylinder. Disconnect air line between solenoid valve and air cylinder, and install a test air pressure gauge as shown. Deplete pressure in coach air system down to 40 to 50 pounds or even less. While observing test gauge have assistant start engine and place air conditioning control to operating position. Note pressure on gauge at time solenoid valve releases air pressure to test gauge. Solenoid valve should be energized (opened) by the air pressure switch at 65 ± 3 pounds. If this does not occur, replace air pressure switch (fig. 54), then recheck.

LUBRICATION

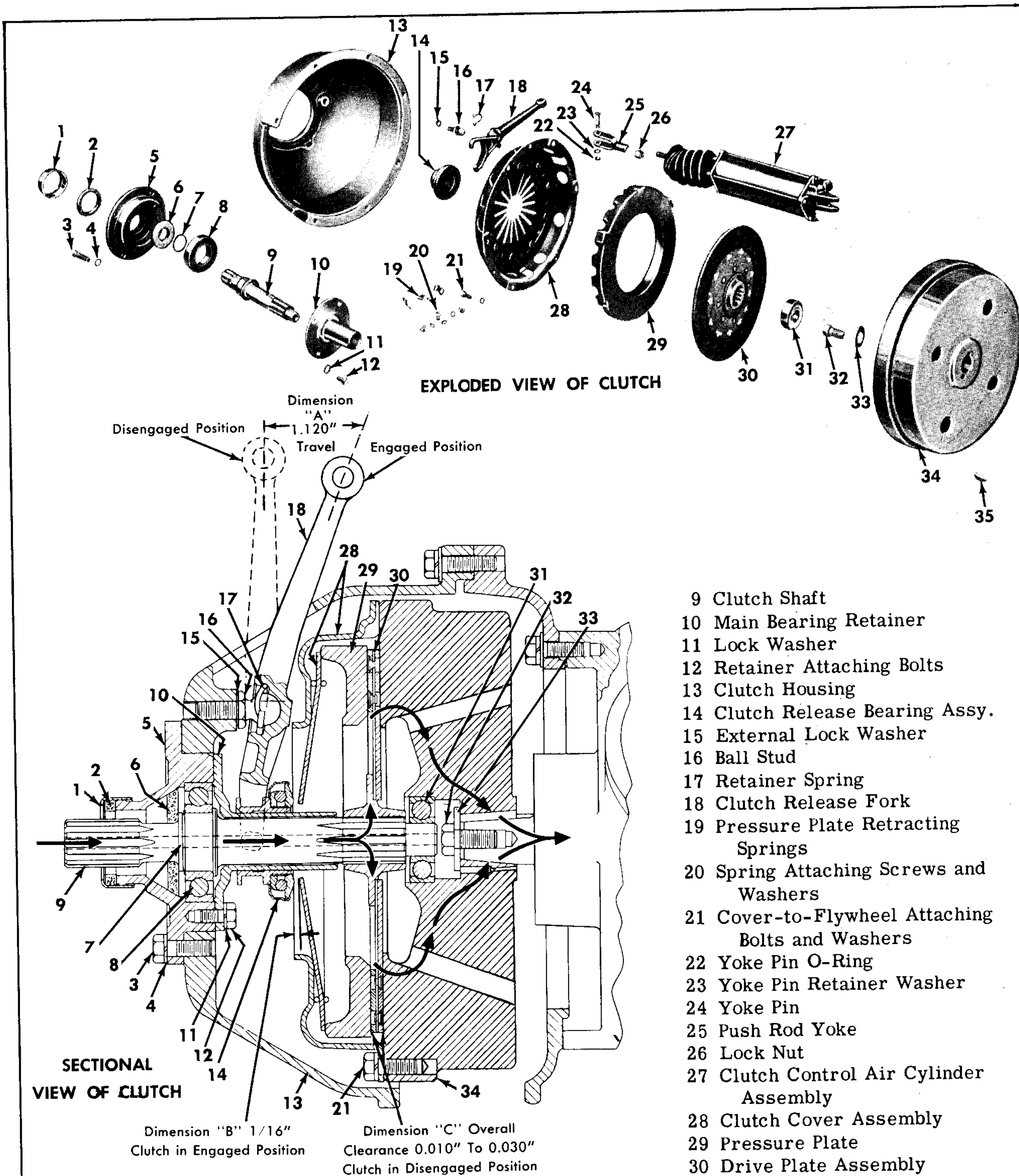
After each three months of operation, two small square head plugs should be removed from end covers of clutch control air cylinder and 1/2 oz. of SAE 10W engine oil injected into cylinder. Replace plugs firmly after adding lubricant.

At regular chassis lubrication intervals, apply Non-Melting Grease, No. 2 Grade with extreme pressure properties to fitting at each joint of compressor drive shaft assembly and to fitting on shaft slip yoke.

Before placing system in season operation and at periodic chassis lubrication intervals, the clutch release bearing surface of retainer, item 10, figure 57, and the pin at each end of clutch air cylinder should be lubricated. Access to the bearing retainer can be obtained by removing the compressor compartment dust shield and using a small long-handled brush to reach into access hole to underside of clutch housing. Use grease containing zinc oxide.

COMPRESSOR CLUTCH RELEASE FORK ADJUSTMENT

At regular intervals the over-all clearance between the clutch driven plate, the pressure plate, and the compressor flywheel (dimension "C", fig. 57) should be checked. Clearance should



1 Cork Seal Retainer Cap
2 Cork Seal
3 Carrier Attaching Bolt
4 Lock Washer
5 Main Bearing Carrier
6 Felt
7 Bearing Retainer Ring
8 Main Bearing Assembly
9 Clutch Shaft
10 Main Bearing Retainer
11 Lock Washer
12 Retainer Attaching Bolts
13 Clutch Housing
14 Clutch Release Bearing Assy.
15 External Lock Washer
16 Ball Stud
17 Retainer Spring
18 Clutch Release Fork
19 Pressure Plate Retracting Springs
20 Spring Attaching Screws and Washers
21 Cover-to-Flywheel Attaching Bolts and Washers
22 Yoke Pin O-Ring
23 Yoke Pin Retainer Washer
24 Yoke Pin
25 Push Rod Yoke
26 Lock Nut
27 Clutch Control Air Cylinder Assembly
28 Clutch Cover Assembly
29 Pressure Plate
30 Drive Plate Assembly
31 Pilot Bearing Assembly
32 Flywheel Bolt
33 Flat Washer
34 Flywheel
35 Flywheel Drive Key

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Figure 57—Compressor Drive Clutch Components

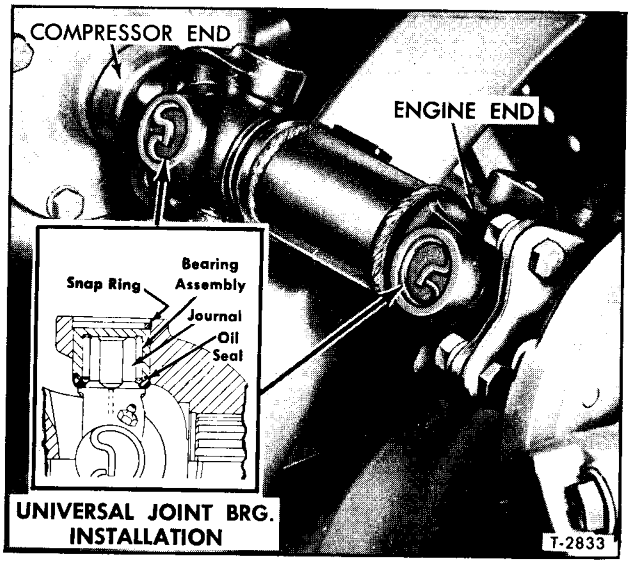


Figure 58—Compressor Drive Propeller Shaft

measure 0.010" to 0.030". This is accomplished as follows: With clutch disengaged, air cylinder push rod extended, measure plate clearance through hole in bottom of clutch housing and one of the holes in pressure plate cover (fig. 55). Clutch cover must be rotated so that holes will line up to insert feeler. If clearance is not as specified, make adjustment as follows:

With clutch cylinder push rod in the retracted position, or air pressure applied, and with release bearing resting against the Belleville spring, locate yoke on push rod so that hole in clutch release fork is about two-thirds of a hole out of line with hole in yoke, the hole in fork being further away from the air cylinder. Swing release fork so that its hole will line up with yoke hole and insert pin. Extend push rod by shutting off air supply to air cylinder. Push rod should move out a minimum of 1.120 inches (fig. 56). Measure plate clearance through hole in bottom of clutch housing. If clearance is not enough, thread yoke further out on push rod and vice versa.

With clutch in the engaged position (air pressure applied), release bearing should clear the Belleville spring by at least 1/16 inch (dimension "B," fig. 57). If there is less than 1/16 inch it means that more stroke is being applied to spring than is necessary to get 0.010-0.030 inch plate clearance. Distance of release bearing from Belleville spring can be checked by removing pin through yoke and release fork and swinging bearing against spring by hand. Then gradually move bearing away from spring, observing distance the outer end of release fork travels. A 7/64 inch movement at outer end is equal to 1/16 inch at the inner end. After correct adjustment is obtained, lock jam nut against yoke and place rubber holding washer and O-ring on end of pin (see inset, fig. 56).

COMPRESSOR DRIVE PROPELLER SHAFT

The compressor drive propeller shaft is of torsional-type for the purpose of dampening out engine torsionals during normal operation of compressor.

Fixed-yoke end of shaft is flange-bolted to the engine accessory drive and the opposite end of shaft is slip-yoke mounted to compressor clutch shaft which is splined. Shaft universal joint bearings are of needle-type and can be readily replaced as directed later under "Universal Joint Bearing Replacement." To avoid early failure of joint bearings and other drive line components, it is necessary that the compressor and propeller shaft be aligned properly. Instructions for making check and alignment are explained earlier under "Compressor Installation."

Propeller shaft assembly is equipped with three lubrication fittings, one at each joint, and one at the splined yoke on clutch drive shaft.

IMPORTANT: Use a hand gun when lubricating the slip-yoke fitting, as over-lubricating may force lubricant into the clutch disc and cover area. Lubricate all three fittings with SPECIAL lubricant specified in LUBRICATION (SEC. 13). Apply one pump of gun every 3,000 miles of vehicle operation.

PROPELLER SHAFT REMOVAL

NOTE: Figure 58 shows propeller shaft installed.

Remove four bolts, nuts, and washers which attach propeller shaft flange to engine accessory drive shaft flange. Separate flanges then pull opposite end of shaft from splined compressor clutch shaft.

PROPELLER SHAFT INSTALLATION

NOTE: Refer to figures 58 and 60.

NOTE: Slip yoke cork seal and cap on clutch housing can be readily replaced after prying cap from housing. If necessary, install new seal and cap. Crimp cap edges in three places over housing extension.

Coat splines of clutch shaft with special grease, then engage slip-yoke end of shaft assembly over splines of compressor clutch shaft and attach flange at opposite end to engine flange with four bolts, nuts, and lock washers. Tighten bolt nuts firmly.

UNIVERSAL JOINT BEARING REPLACEMENT
(Refer to Fig. 58)

Removal

1. Remove snap rings which retain bearings in shaft yokes.

2. Strike one side of yoke with soft hammer to force one bearing assembly out of yoke. Strike opposite side of yoke to force opposite bearing out.

CAUTION: DO NOT DROP BEARINGS.

3. Journal can now be tilted to permit removal of yoke from journal.

4. Remove the remaining two bearing assemblies in same manner to permit removing journal from other yoke.

Installation

1. NOTE: Make sure oil seals are in place securing needle rollers in bearing. Apply recommended grease to needles to provide initial lubrication.

2. Install journal in yoke, then install bearing assemblies in yoke over journal trunnions. Use a soft hammer to tap bearings into place.

3. Install snap rings into yoke groove to secure bearings in yoke. IMPORTANT: Make sure snap rings are fully seated in yoke grooves.

PROPELLER SHAFT ALIGNMENT

IMPORTANT: The compressor must be aligned properly with engine drive shaft, otherwise early failure of the drive shaft bearings and other drive line components will occur.

The air conditioning compressor alignment must be checked whenever any of the following conditions occur:

1. The vehicle is involved in a rear end collision.
2. The engine is removed.
3. The air conditioning unit is removed.
4. The engine stabilizer bars are disturbed.
5. The engine support mounting insulators are replaced.
6. Any other incidents which may disturb the engine mountings and supports, or the air conditioning compressor in any way.

Procedures to properly align compressor to accessory drive unit are listed previously under "Compressor Installation" in this section.

REFRIGERANT COMPRESSOR DRIVE CLUTCH

The compressor drive clutch (fig. 57), enclosed by an aluminum housing, is mounted to drive end of compressor. Clutch is of the conventional automotive type and is actuated by an air-powered cylinder assembly mounted to side of compressor.

When air CYLINDER IS PRESSURIZED (push rod retracted, the CLUTCH BECOMES ENGAGED. Likewise when PRESSURE IS EXHAUSTED from cylinder (push rod extended) CLUTCH BECOMES DISENGAGED. NOTE: Air cylinder push rod is extended by pressure of two coil springs within cylinder assembly.

The clutch input shaft, which is propeller shaft driven from engine accessory drive, is engaged directly to the clutch drive plate assembly. Thus the drive plate is turning whenever the coach engine is running. When clutch is engaged by action of the air cylinder, the Belleville spring of clutch pressure plate is released. This action releases pressure plate to engage both drive plate and compressor flywheel to turn the compressor. Large arrows on figure 57 indicate the power flow from the drive shaft input through the clutch to the compressor. Clutch components can be replaced without having to remove compressor from coach.

Overhaul of the clutch components are explained later under "Clutch Overhaul."

CLUTCH DRIVE PLATE AND COVER ASSEMBLY REPLACEMENT

IMPORTANT: One special tool, which can be improvised locally, is necessary for making these replacements. DO NOT ATTEMPT TO MAKE REPLACEMENTS UNLESS THIS TOOL IS AVAILABLE. Tool is used for holding drive plate in alignment when installing cover assembly to clutch flywheel. Cut off a portion of an old clutch shaft at a point shown in figure 59. This part can also be made up from an old Chevrolet mechanical transmission main drive (clutch) gear.

1. Using run-up blocks, raise rear of coach to provide access below compressor compartment. Set parking brake.

2. Place engine control switches in engine compartment to "OFF" position.

3. Remove stone shield from below compressor and from under engine at left side.

4. Remove compressor drive shaft assembly. NOTE: If necessary to rotate shaft for access to flange bolts, turn engine crankshaft using a 1-1/2 inch socket wrench on lower crankshaft pulley nut.

5. Spring-loaded clutch cylinder (27, fig. 57) must be disconnected from clutch release fork (18, fig. 57). In order to remove fork connecting pin (24, fig. 57), disconnect cylinder air line hose at air control solenoid valve, then apply shop air

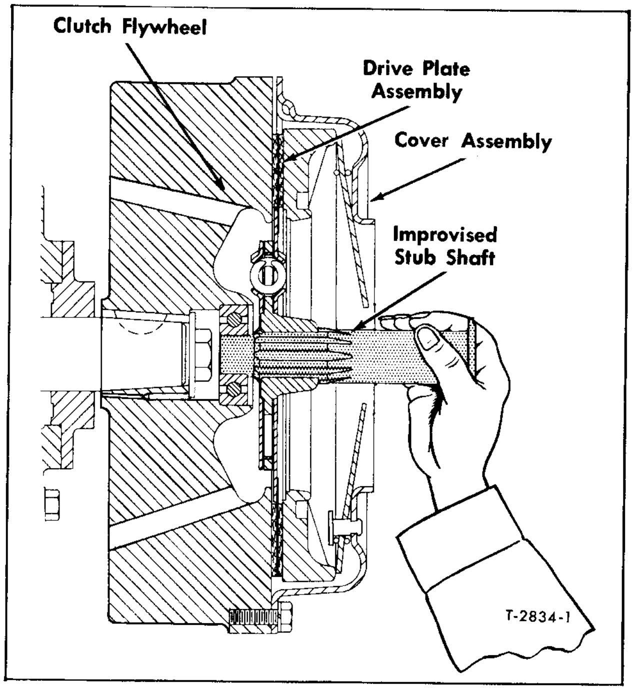


Figure 59—Using Improvised Shaft For Installing Clutch

pressure through hose into air cylinder (min. air pressure required - 65 lbs.). This action will relieve pressure on cylinder yoke pin, allowing pin to be removed.

6. Remove bolts which attach clutch housing to compressor adapter. Separate housing evenly from compressor.

7. Move clutch housing rearward into propeller shaft opening in body bulkhead or remove housing from compartment if desired. Remove clutch cover attaching bolts evenly, then remove

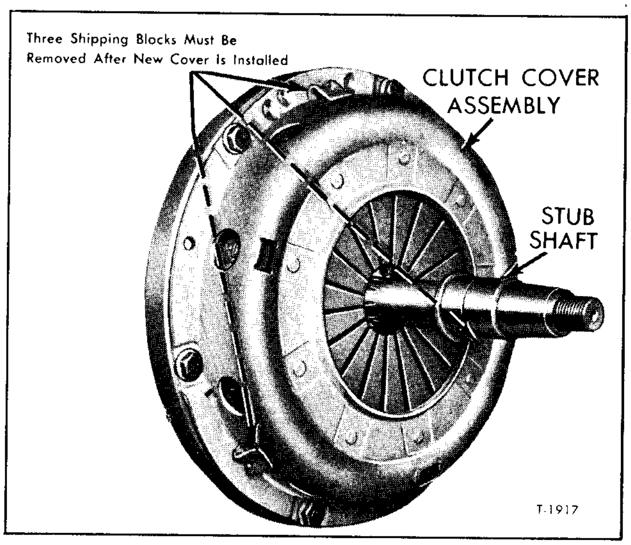


Figure 60—Clutch Shipping Blocks Installed

clutch drive plate and cover assembly from flywheel.

NOTE: Compressor flywheel and pilot bearing can be replaced as directed later under "Clutch Overhaul." Also, the clutch shaft can be separated from housing as directed later under "Clutch Housing and Shaft Disassembly."

INSTALLATION OF DRIVE PLATE AND COVER ASSEMBLIES

NOTE: Before installing clutch components, check pilot bearing for roughness, lack of lubricant, and also check friction surface of flywheel. Repair or replace if necessary. The cavity within the flywheel pilot bearing should also be full of "SPECIAL" lubricant listed in LUBRICATION (Sec. 13).

1. Locate clutch drive plate assembly and clutch cover assembly to flywheel.

IMPORTANT: Make sure that stamped side (PRESSURE PLATE SIDE) of drive plate is properly positioned. If plate is not stamped, the large rivet heads at hub should be located towards the flywheel.

2. Using improvised stub shaft as shown in figure 59, insert shaft into splines of drive plate and then into pilot bearing within clutch flywheel.

3. Carefully line up clutch cover with flywheel, then install cover attaching bolts and lock washers alternately. This will prevent distorting clutch cover when compressing clutch spring.

IMPORTANT: If a new cover assembly was installed, pry these shipping blocks from around cover. Blocks are located as shown in figure 60.

NOTE: Cover attaching bolts should be tightened to approximately 40 foot-pounds torque. Remove improvised stub shaft from clutch drive plate.

4. Position clutch housing assembly with shaft over clutch to housing adapter. Rotate clutch shaft to engage drive plate splines and then the pilot bearing. Attach housing evenly to adapter with seven bolts and washers. Tighten bolts firmly.

5. Apply shop air pressure to clutch control air cylinder, then install cylinder to release fork clevis pin, pin (washer) retainer, and rubber O-ring (24, 23, and 22, fig. 57). Attach cylinder air line to air control solenoid valve.

6. Install compressor drive shaft assembly.

NOTE: It may be necessary to rotate engine flange for alignment of shaft with clutch shaft splines.

7. Fasten stone shields under compressor and engine.

8. Place engine control switches in the engine compartment in operating positions.

9. Remove coach from run-up blocks.

CLUTCH OVERHAUL

CLUTCH HOUSING AND SHAFT DISASSEMBLY

Key numbers in text refer to figure 57.
Figure 61 shows assembly removed.

1. Using open-end wrench, turn ball stud (16) and lock washer (15) from clutch housing. Remove stud with clutch release fork (18). Slide release bearing (14) from retainer (10). Remove retainer spring (17) holding ball stud in fork.

2. Remove four bolts (3) and lock washers (4) which attach main bearing carrier (5) with shaft as a unit from housing.

3. Remove four bolts (12) and lock washers (11) attaching main bearing retainer (10) to main bearing carrier. Remove retainer and carrier from clutch shaft (9). Remove felt (6) from carrier.

4. Using snap ring pliers, remove bearing retainer ring (7) from clutch shaft. Using arbor press, force main bearing assembly (8) from shaft.

ASSEMBLY OF CLUTCH HOUSING AND SHAFT

Key numbers in text refer to figure 57.
Figure 61 shows assembly removed.

1. Press main bearing assembly (8) onto clutch shaft (9), making sure unshielded side of bearing is toward flange on shaft.

2. Install bearing retainer ring (7) into ring groove on shaft.

3. Pack cavity of main bearing carrier (5) with same grease recommended for compressor drive shaft. Refer to LUBRICATION (SEC. 13). Install felt (6) in carrier over the grease with taper of seal positioned to mate taper in carrier. Referring to figure 57 for position of parts, place carrier on shaft and bearing, then position main bearing retainer (10) over bearing to carrier. Install retainer to carrier with four bolts and lock washers. Tighten bolts firmly.

4. Install carrier and shaft assembly into clutch housing with four bolts and lock washers. Tighten bolts evenly and firmly. NOTE: It may be necessary to tap carrier into housing.

5. Pack ball stud socket of clutch release fork (18) with wheel bearing grease, then insert ball stud (16) into socket. Secure stud with retainer spring (17). Make sure both ends of spring are located in fork.

6. Slide clutch release bearing (14) over main bearing retainer to position shown in sectional view of figure 55.

7. Install clutch release fork (18) to clutch housing, using new external lock washer on ball stud. Tighten stud firmly. Figure 61 shows assembly built up.

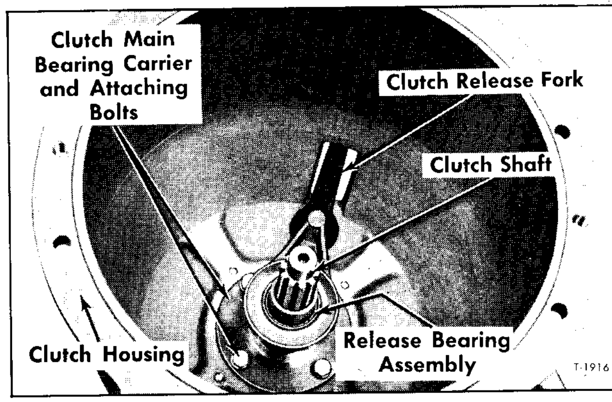


Figure 61—Clutch Fork and Drive Shaft Installed in Clutch Housing

CLUTCH PRESSURE PLATE AND COVER DISASSEMBLY

Key numbers in text refer to figure 57.

NOTE: Check clearance between driving lugs of pressure plate (29) and mating slots in clutch cover (28) in manner shown in figure 62. If clearance is greater than 0.008", examine cover and lugs of pressure plate for wear and if necessary, replace worn parts.

If locating marks "O" on cover and pressure plate (fig. 62) are not visible, mark parts as shown. Remove pressure plate retracting spring bolts (20), remove springs (19), then separate pressure plate from cover.

NOTE: Pressure plate can be resurfaced and other components checked as directed later under "Inspection and Repair."

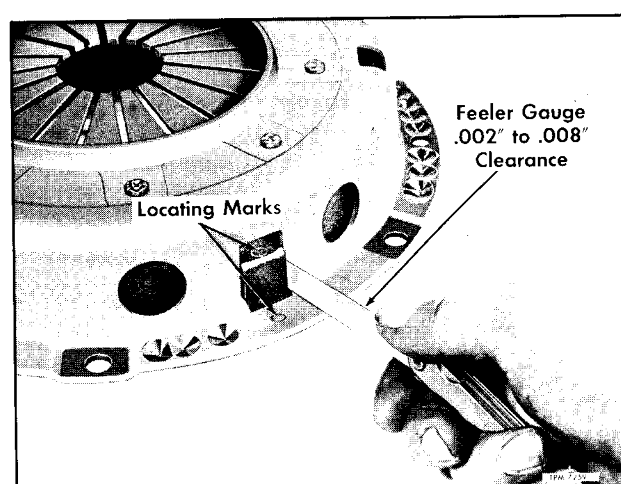


Figure 62—Clutch Cover-To-Plate Alignment Marks and Driving Lug Clearance Check

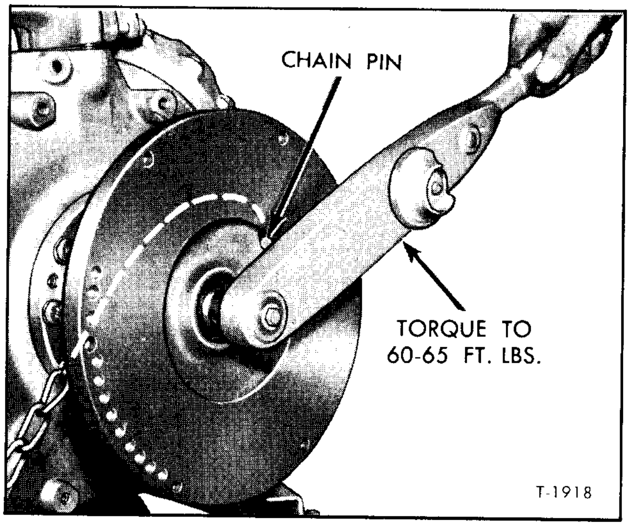


Figure 63—Tightening Flywheel Bolt (Typical)

ASSEMBLY OF CLUTCH PRESSURE PLATE AND COVER

Key numbers in text refer to figure 57.

1. Apply light coat of graphite grease on sides of pressure plate driving lugs; then install plate in cover, making sure balance mark "O" on cover (28) is matched with corresponding mark on pressure plate (29). Refer to figure 62.

2. Install three retracting springs (19) on pressure plate (29). There must not be any clearance between clutch spring and retracting spring when spring attaching screws are tight.

CLUTCH FLYWHEEL AND PILOT BEARING REPLACEMENT

Key numbers in text refer to figure 57.

Removal

1. Remove pilot bearing (31) from compressor flywheel, using a conventional bearing puller tool.

2. Using proper size wrench socket, remove bolt (32) and flat washer (33) which attach flywheel (34) to compressor shaft (fig. 63). Remove flywheel and flywheel key (35). Flywheel can be resurfaced as directed later. Pilot bearing can also be checked as directed under "Inspection and Repair."

NOTE: Flywheel can be retained when loosening or tightening flywheel bolt using a large cotter pin, chained to compressor platform (fig. 63). Insert pin from back side.

Installation

NOTE: Apply a light film of SAE 10 oil to taper of compressor shaft.

1. Insert drive key (35) into slot of compressor crankshaft, then with flywheel aligned, position flywheel to compressor. Install flywheel flat washer (33) and special bolt (32). Tighten bolt to 60 to 65 ft.-lbs. torque in manner shown in figure 63.

2. Pack cavity around head of flywheel attaching bolt with special grease recommended for propeller shaft in LUBRICATION (SEC. 13); then press pilot bearing (31) evenly into flywheel.

IMPORTANT: Shielded side of bearing must face cavity.

INSPECTION AND REPAIR OF CLUTCH COMPONENTS

Key numbers in text refer to figure 57.

1. Wash all parts in cleaning solvent, except bearings and clutch drive plate assembly (30).

2. Carefully examine clutch cover and spring assembly (28). Check spring for wear at inner end of levers at point contacted by release bearing (14). Also look for wear and fractures at outer rim of clutch spring. Replace complete cover and spring assembly if any of the component parts are damaged or worn.

3. Inspect pressure plate (29) for scoring on contact surface. Regrind pressure plate if plate is grooved, rough, heat checked, or cracked. Replace with new plate if distorted or if driving lugs are worn.

4. Inspect contact surface of compressor flywheel (34) for grooved or worn condition. Flywheel can also be ground down as explained later.

5. Replace pilot bearing (31), clutch release bearing (14), and clutch shaft main bearing (8) if bearings are rough or damaged.

RESURFACING PRESSURE PLATE

Before resurfacing pressure plate, a check should be made to determine whether plate has been resurfaced previously. This may be determined by measuring from the front surface of plate to the surface at rear side which is contacted by the Belleville spring. Dimensions of new pressure plate is 1.0945" to 1.0970". Not more than 0.045 inch of stock may be removed from contact surface by grinding. If pressure plate is to be resurfaced, proceed as follows:

1. Grind off friction surface of pressure plate as necessary to produce a flat surface. If necessary to reduce plate thickness more than 0.045 inch to restore smooth flat surface, plate should be discarded and replaced with a new part.

2. After plate has been resurfaced, measure thickness as directed above. Subtract thickness of resurfaced plate from thickness of new plate to determine how much stock has been removed during resurfacing operation.

RESURFACING COMPRESSOR FLYWHEEL

Grind from wear surface of flywheel rim, the same amount of stock as was removed from pressure plate. This is necessary to maintain torque capacity of clutch. When refacing is done properly, the clutch spring will be flat when clutch parts are assembled to flywheel, that is, the inner end of fingers will be in same plane as the outer rim of spring, or fingers may slant slightly rearward.

CLUTCH CONTROL AIR CYLINDER

Clutch control air cylinder (fig. 65), pivot-mounted to side of compressor, is employed to engage and disengage the compressor clutch. When cylinder push rod is retracted by air pressure supplied by the control air solenoid valve, clutch becomes engaged. When solenoid valve closes, exhausting air supply to cylinder, springs within cylinder extend the push rod to cause clutch to become disengaged.

Air, which is drawn into vented end of air cylinder when clutch is disengaged, enters through an air strainer assembly, mounted to pivot end of cylinder. Air strainer should be removed and cleaned after every three months of operation, or more often if subject to operation under extreme dusty conditions.

At 10,000 mile intervals, one ounce of clean SAE 10 engine oil should be admitted into cylinder after removing small hex plug.

AIR CYLINDER REMOVAL

1. Disconnect coach air supply line at air cylinder and apply shop air pressure to cylinder to free clevis pin at clutch release fork.
2. Remove rubber O-ring and flat rubber washer at lower end of cylinder push rod yoke pin. Remove pin from yoke and clutch release fork, then disconnect shop air pressure from cylinder.
3. Remove O-ring retainer and remove pin and four thrust washers from pivot-end of cylinder attached to compressor brackets (fig. 64). Carefully lower cylinder from compartment.

NOTE: Do not lose O-ring retainer or thrust washers from compressor bracket end of cylinder (fig. 64).

4. If necessary, remove air strainer assembly from rear cover of cylinder. Instructions for cleaning air strainer are explained later under "Cylinder Air Strainer."

AIR CYLINDER INSTALLATION

1. Check to see that attaching bolts of cylinder pivot mounting bracket are tight.
2. Apply small quantity of Lubriplate to pivot

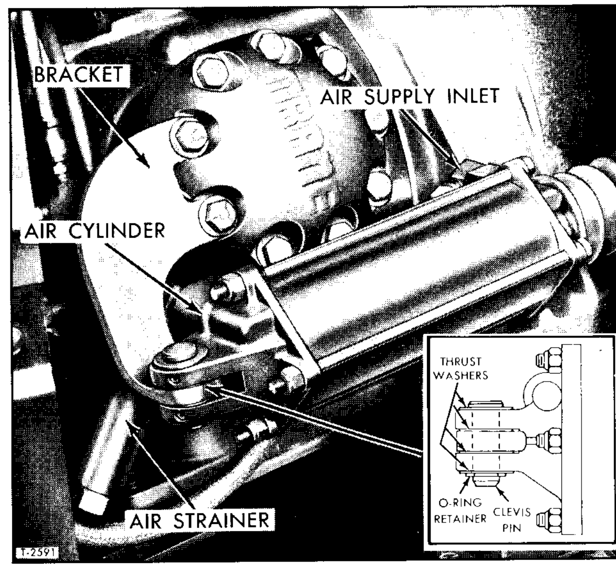


Figure 64—Clutch Control Air Cylinder Installed

end of cylinder and to yoke at push rod end of cylinder.

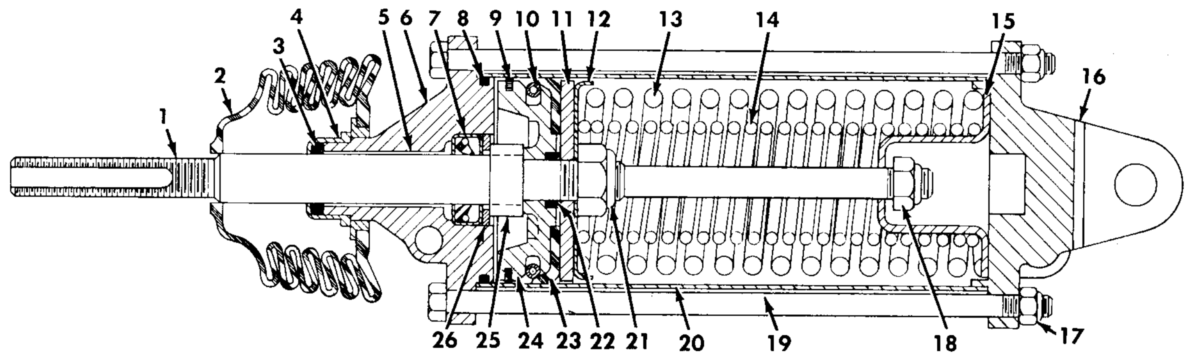
3. Raise cylinder assembly into position. Locate washers as shown in figure 64. Attach pivot end of cylinder to mounting bracket with clevis pin and O-ring retainer.
4. Connect shop air supply line to air cylinder to retract cylinder push rod.
5. Check and adjust clutch control as explained previously under "Clutch Release Adjustment."
6. After proper adjustment is obtained, make certain that flat rubber washer and rubber O-ring (23 and 22, fig. 57) are installed to lower end of push rod yoke pin. See insert on figure 56.
7. Connect air line.

CYLINDER OVERHAUL

DISASSEMBLY

Key numbers in text refer to figure 65.

1. Mark cylinder front cover (6), cylinder tube (20), and rear cover (16) to assure proper alignment when assembled later.
2. Remove boot (2) from push rod and front cover.
3. Remove nut (17) from ends of four bolts (19) retaining cylinder assembly together. Remove bolts.
4. Separate front cover (6) with push rod and springs from cylinder tube and rear cover. Slide front cover (6) from push rod, being careful not to damage push rod seal (7).
5. Remove O-ring (8) from groove of front cover.



1 Push Rod
2 Push Rod Boot
3 Seal
4 Seal Cap
5 Push Rod Bushing
6 Front Cover Assembly
7 Push Rod Seal Assembly
8 Tube O-Ring
9 Piston Felt
10 Expander Spring
11 Piston Plate
12 Spring Retainer
13 Spring (Large Diameter)
14 Spring (Small Diameter)
15 Spring Retainer Cup
16 Rear Cover
17 Nut
18 Push Rod Nut
19 Bolt
20 Cylinder Tube
21 Push Rod Nut
22 O-Ring
23 Piston Cup
24 Piston Follower
25 Spacer
26 Seal Washer

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Figure 65—Clutch Control Air Cylinder Assembly

NOTE: At this point of disassembly the condition of piston components can be checked. To disassemble piston components, an arbor press having sufficient travel is necessary for compressing springs to allow removal of inner push rod nut (18).

CAUTION

DO NOT ATTEMPT TO DISASSEMBLE OR ASSEMBLE SPRINGS WITHOUT PROPER EQUIPMENT, AS SERIOUS INJURY COULD RESULT.

6. Using arbor press with a suitable fixture that will prevent the springs from "snaking" out of position, remove push rod nut (18). Carefully back off arbor press to remove tension on springs. Remove spring retainer cup (15) and springs.
7. Remove push rod nut (21), then remove spring retainer (12), piston plate (11), piston cup (23), expander spring (10), and piston felt (9).
8. O-ring (22) can be removed from piston follower (24).
9. Slide spacer (25) from push rod.
10. If necessary, seal washer (26) and seal assembly (7) can be removed from front cover (6).

CLEANING AND INSPECTION

Clean all parts thoroughly, then inspect cylinder tube (20) and piston cup (23).

ASSEMBLY

Key numbers in text refer to figure 65. Refer to this view for positioning of parts when assembling unit.

1. Install new seal assembly (7) into front cover (6). IMPORTANT: Lip of seal must face piston components.) Install seal washer (26). Stake washer in four places.
2. Slide small diameter end of push rod (1) into boot end of front cover (6) and through seal.
3. Place spacer (25) into position on push rod.
4. Place piston follower (24) on push rod, then install small O-ring (22) into recess of follower.
5. Referring to figure 65 for proper positioning of parts, install piston felt (9) and expander spring (10) into grooves of follower (24), install piston cup (23), piston plate (11), spring retainer (12) and new push rod nut (25). Tighten nut firmly.
6. Place push rod and front cover in arbor press fixture, then place springs (13 and 14) into position. Carefully press spring retainer cup (15) over end of push rod to allow installation of new push rod nut (18). Tighten nut firmly.
7. Locate tube O-ring (8) into groove of front cover.
8. Coat inside of cylinder tube (20) with Lubriplate, then place tube over springs to front cover. Locate rear cover (16) to tube. Align marks on tube and covers which were made prior to disassembly. Install four bolts (19) and nuts (17). Tighten nuts evenly.
9. If previously removed, install seal (3) and

seal cap (4).

10. Apply small quantity of clean grease to push rod, then install push rod boot (2) to front cover.

CYLINDER AIR STRAINER

Air strainer (fig. 66), installed at pivot end of air cylinder, should be removed and cleaned after every three months of operation, or more often if subject to extreme dusty conditions.

Soak strainer material in cleaning solution, then flush strainer. Allow material to dry, then assemble strainer. Replace gaskets if necessary.

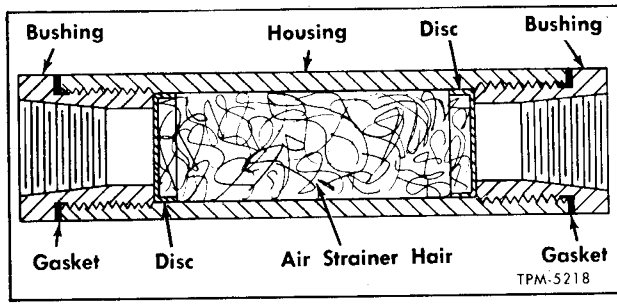


Figure 66—Air Strainer Assembly

Tighten end bushings firmly. Install strainer to air cylinder.

COMPRESSOR ACCESSORY DRIVE

The accessory drive, as used to transfer power of coach engine to operate the air conditioning refrigerant compressor, consists of a bevel drive gear and pinion enclosed within engine fan drive housing, as shown in figure 67.

Referring to figure 67, engine torque is transferred from fan drive pinion (17) to the bevel gear (16) at a ratio of 1.0 to 1.59.

Bevel gear (16, fig. 67) is supported in bearing retainer (8, fig. 67) on two tapered roller bearings which are lubricated by engine oil pressure through internal drilled passages. Bearing retainers (8 and 35, fig. 67) of both gears can be 0.001" press fit to 0.001" loose fit in opening of accessory drive housing.

BEVEL GEAR AND PINION ARE USED IN MATCHED SETS ONLY.

Adjustment of gear backlash and tooth contact is accomplished by removing or adding shims (9 and 37, fig. 67) which relocate position of one gear in relation to the other. Instructions for making adjustments are explained later under "Bevel Gear and Pinion Adjustments."

BEVEL GEAR AND BEARING RETAINER REMOVAL

Key numbers in text refer to figure 67.

1. Remove nut (1) which attaches propeller shaft flange (3) to drive gear (16). Remove flange and flange key (38).
2. Mark position of bearing retainer (8) in relation to accessory drive housing to assure original position when installing later.
3. Remove bearing retainer bolts and lock washers.
4. Install two puller screws into tapped holes in bearing retainer and force bearing retainer evenly from housing. Remove puller screws. Retain shim pack (9) to assure original gear backlash if it was found satisfactory.
5. Disassemble bevel gear and retainer unit as explained later under "Bevel Gear and Bearing Retainer Disassembly."

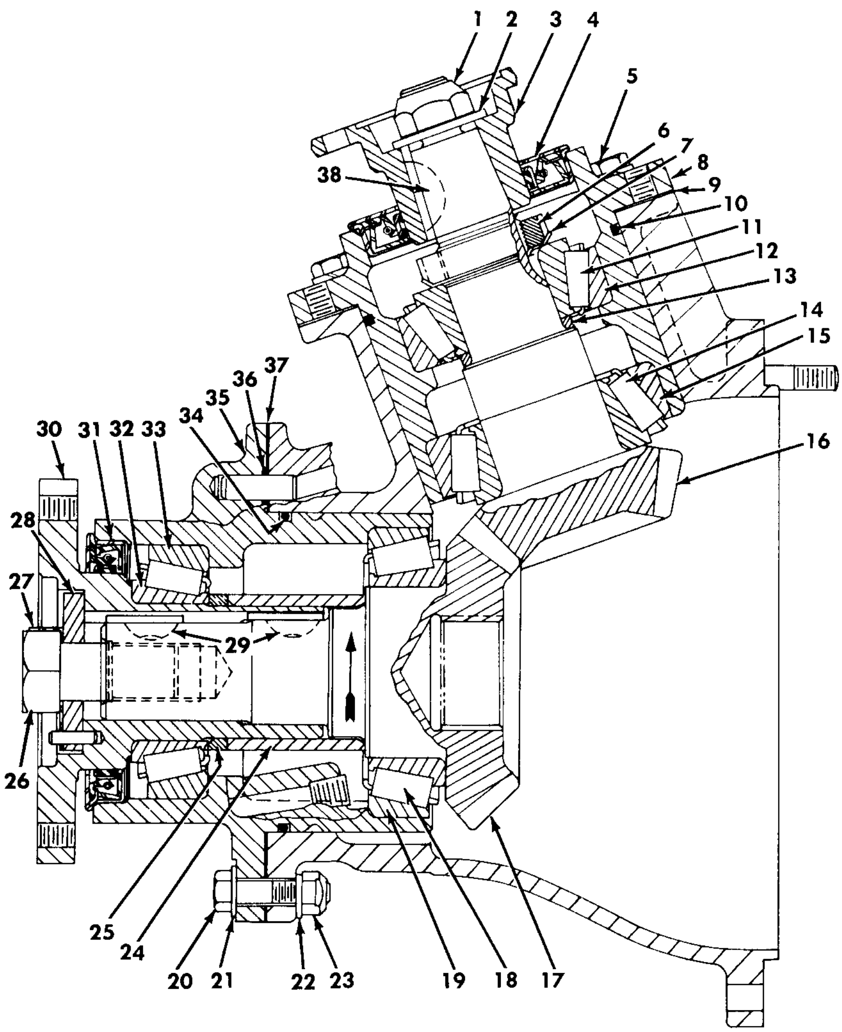
BEVEL GEAR AND BEARING RETAINER DISASSEMBLY

Key numbers in text refer to figure 67.

1. Remove O-ring seal (10) from groove in bearing retainer.
2. Using sharp bladed tool, pry oil seal assembly (4) from bearing retainer.
3. Bend down tab of adjustment nut lock (7).
4. Position bevel gear assembly in a vise having soft jaws, then remove adjustment nut (6). Remove nut lock.
5. Support bevel gear retainer (4) in an arbor press and force bevel gear with inner bearing cone (14) and bearing adjustment spacer (13) from retainer. Remove spacer from shaft. If inner bearing needs replacement, remove bearing using arbor press and remover plates.
6. Remove outer bearing cone assembly (11) from retainer.
7. If necessary, bearing cups (12 and 15) can be removed from retainer, using suitable puller equipment.

CLEANING AND INSPECTION

1. Clean all parts in cleaning solvent. Wipe or blow parts dry.
2. Inspect rollers of bearing cones for nicks and worn spots. Inspect bearing cups also for indication of wear. Replace cones and cups if not in good condition. After cleaning and inspection of bearing parts, lubricate parts generously with clean engine oil, then wrap in clean lint-free cloth or paper until ready to install.



1 Lock Nut
2 Washer
3 Flange
4 Oil Seal
5 Bolt
6 Lock Nut
7 Lock Washer
8 Bevel Gear Bearing Retainer
9 Shims (As Req'd.)
10 O-ring
11 Bevel Gear Outer Bearing
12 Outer Bearing Cup
13 Bearing Spacer (Selective)
14 Bevel Gear Inner Bearing
15 Inner Bearing Cup
16 Bevel Gear
17 Pinion Gear
18 Pinion Gear Inner Bearing
19 Inner Bearing Cup
20 Bolt
21 Flat Washer
22 Lock Washer
23 Lock Nut
24 Bearing Spacer
25 Bearing Spacer (Selective)
26 Bolt
27 Lock Plate
28 Washer Assembly
29 Keys
30 Fan Drive Hub
31 Oil Seal
32 Pinion Gear Outer Bearing
33 Outer Bearing Cup
34 O-ring
35 Pinion Gear Bearing Retainer
36 O-ring
37 Shims (As Req'd.)
38 Key

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Figure 67—Compressor Accessory Drive

3. Check teeth of bevel gear for poor tooth contact pattern, nicks, or worn condition.

> **NOTE**
>
> Bevel gear and pinion are serviced in matched set only.

ASSEMBLY OF BEVEL GEAR AND BEARING RETAINER

Key numbers in text refer to figure 67. Coat all parts in clean SAE 30 engine oil when assembling unit.

1. If bevel gear inner bearing cone (14) was removed from bevel gear at disassembly, install inner bearing cone using a suitable sleeve and arbor press. Support bevel gear on soft metal or

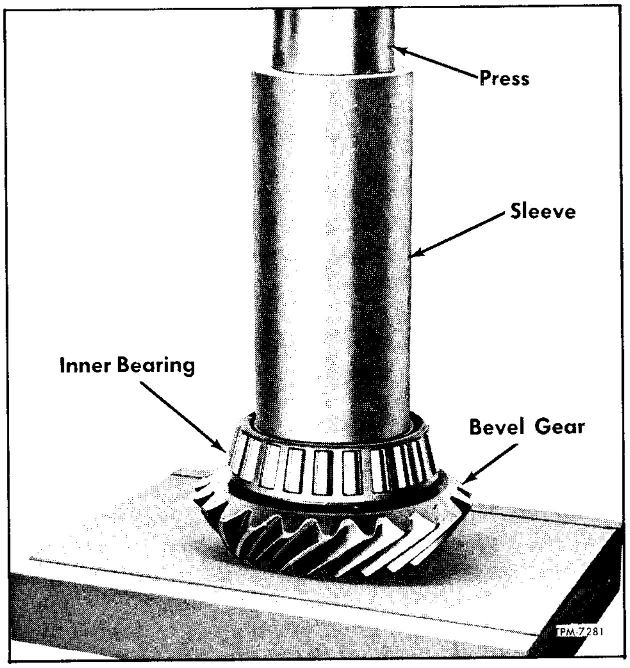


Figure 68—Installing Bevel or Pinion Gear Inner Bearing

hardwood block and seat bearing race firmly at shoulder (fig. 68).

2. Install bearing adjustment spacer (13) on shaft of bevel gear.

3. Inspect counterbores in bearing retainer (18) which must be clean.

4. Use a suitable driver and arbor press and install bearing cups (12 and 15) in retainer.

5. Apply engine lubricant on bearing assemblies; then set the retainer in place on bevel gear, making sure key (38) is in shaft.

6. Install outer bearing cone (11), adjustment nut lock (7), and adjustment nut (6). NOTE: Care should be taken to prevent nut lock from turning with adjustment nut.

7. Support teeth of bevel gear in a soft jaw vise; then adjust gear bearing preload as follows:

a. Tighten bearing adjustment nut (6) to 175 to 200 ft.-lbs. torque.

b. Wrap a heavy cord around bearing retainer and attach a spring scale as shown in figure 69. Rotate bearing retainer by pulling on spring scale. Correct bearing preload will require a 5 to 15 pound pull to rotate retainer. If necessary, replace bearing adjustment spacer (13) with another size. Select smaller size to increase preload; larger size to decrease preload.

Spacers of various sizes are available in thicknesses shown in chart at right.

c. When correct adjustment is obtained, lock adjustment nut by bending up tab of adjustment nut lock (7).

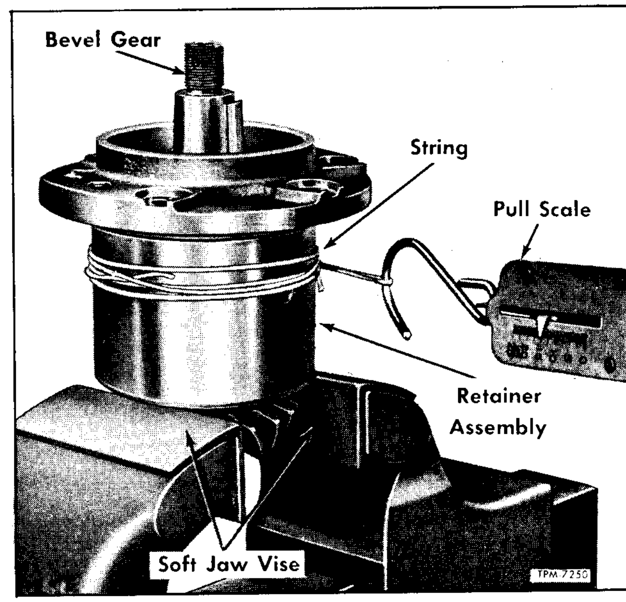


Figure 69—Checking Bevel Gear Adjustment

BEARING SPACER CHART

GM Part No.	Thickness	Stamped
2389880	.224" -.223"	P-24
2397019	.2225"-.2215"	P-225
2369879	.221" -.220"	P-21
2397018	.2195"-.2185"	P-195
2389878	.218" -.217"	P-18
2397017	.2165"-.2155"	P-165
2389877	.215" -.214"	P-15
2397016	.2135"-.2125"	P-135
2389876	.212" -.211"	P-12
2397015	.2105"-.2095"	P-105
2389875	.209" -.208"	P-09
2397014	.2075"-.2065"	P-075
2389874	.206" -.205"	P-06
2397013	.2045"-.2035"	P-045
2389873	.203" -.202"	P-03
2397012	.2015"-.2005"	P-015
2386043	.200" -.199"	P-00
2397011	.1985"-.1975"	P-985
2389872	.197" -.196"	P-97

PINION GEAR AND BEARING RETAINER REMOVAL

Key numbers in text refer to figure 67.

1. Remove bearing retainer attaching bolts (20) and lock washers (21).

2. Install two puller screws into tapped holes in bearing retainer (35). See figure 70. Force bearing retainer evenly from housing by alternately turning puller screws 1/2 turn each. Remove puller screws. Retain shim pack (37) to assure original gear backlash if it was found

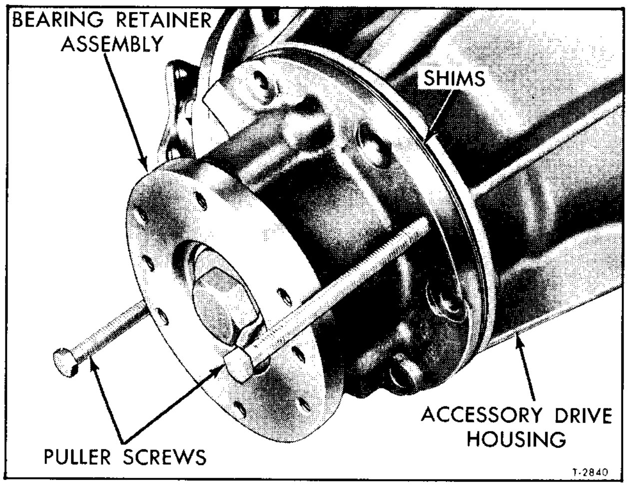


Figure 70—Using Puller Screws To Remove Retainer

satisfactory.

3. Disassembled pinion gear (17) and retainer unit as explained later under "Pinion Gear and Bearing Retainer Disassembly."

PINION GEAR AND BEARING RETAINER DISASSEMBLY

Key numbers in text refer to figure 67.

1. Bend lock plate (27) flush against washer (28).

2. Position pinion gear assembly in a vise having soft jaws, then remove shaft bolt (26), lock plate (27), and washer (28).

3. Support retainer (35) in an arbor press and force pinion gear (17) with inner bearing (18) and spacer (24) from retainer. Remove spacer from shaft. If inner bearing needs replacement, remove bearing using arbor press.

4. Support bearing retainer (35) in an arbor press and force fan drive hub (30) with bearing spacer (25), outer bearing (32), and seal (31) from retainer.

5. Remove bearing spacer (25), bearing (32), and seal (31) from fan drive hub. Use suitable puller to remove outer bearing.

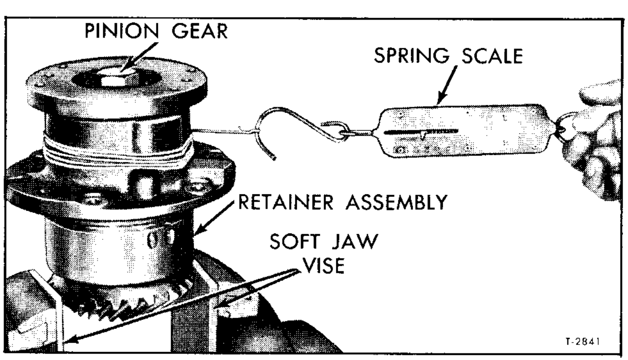


Figure 71—Checking Pinion Gear Adjustment

6. If necessary, bearing cups (19) and (33) can be removed from retainer (35) using suitable puller equipment.

CLEANING AND INSPECTION

Instructions for cleaning and inspecting pinion gear and bearing retainer parts will be the same as specified following "Bevel Gear and Bearing Retainer Disassembly."

ASSEMBLY OF PINION GEAR AND BEARING RETAINER

Key numbers in text refer to figure 67. Coat all parts in clean SAE 30 engine oil.

1. If pinion gear inner bearing cone (18) was removed from gear at disassembly, install bearing cone using a suitable sleeve and arbor press. Support gear on soft metal or hardwood block and seat race firmly at shoulder (fig. 68).

2. Install spacer (24) on shaft of pinion gear.

3. Inspect counterbores in bearing retainer (35) which must be clean.

4. If removed at disassembly, use a suitable driver and arbor press and install bearing cups (19) and (33) in retainer.

5. Apply engine oil on bearing assemblies, then set the retainer in place on bevel gear.

6. Install outer bearing (32) on fan drive hub (30) in arbor press. Apply small amount of grease to inside diameter of bearing spacer (25) and install on fan drive hub.

7. Making sure keys (29) are installed in shaft, press fan drive hub into bearing retainer. Install washer (28), lock plate (27), and bolt (26).

8. Support teeth of bevel gear in a soft jaw vise; then adjust gear bearing preload as follows:

a. Tighten bolt (26) to 200-225 ft. lbs. torque.

b. Wrap a heavy cord around bearing retainer and attach a spring scale as shown in figure 71. Rotate bearing retainer by pulling on spring scale. Correct bearing preload will require a 10 to 20 pound pull to rotate retainer.

c. If necessary, replace bearing adjustment spacer (25) with another size. Select smaller spacer to increase preload, larger size to decrease preload. Spacers of various sizes are available in thicknesses shown in chart on next page.

9. When correct preload is obtained, remove fan drive hub assembly and insert seal (31) in bearing retainer (35). Coat outside of seal with sealing compound before installing.

10. Using spacer plates as shown in figure 72, press fan drive hub assembly into bearing retainer. Remove spacer plates by knocking out with hammer. Plates can be improvised locally according to dimensions called out in figure 72.

BEARING SPACER CHART

GM Part No.	Thickness	Stamped
2389893	.289 -.288	R-89
2397031	.2875-.2865	R-875
2389892	.286 -.285	R-86
2397030	.2845-.2835	R-845
2389891	.283 -.282	R-83
2397029	.2815-.2805	R-815
2389890	.280 -.279	R-80
2397028	.2785-.2775	R-785
2389889	.277 -.276	R-77
2397027	.2755-.2745	R-755
2389888	.274 -.273	R-74
2397026	.2725-.2715	R-725
2389887	.271 -.270	R-71
2397025	.2695-.2685	R-695
2389886	.268 -.267	R-68
2397024	.2665-.2655	R-665
2389885	.265 -.264	R-65
2397023	.2635-.2635	R-635
2389884	.262 -.261	R-62
2397022	.2605-.2595	R-605
2389883	.259 -.258	R-59
2397021	.2575-.2565	R-575
2389882	.256 -.255	R-56
2397020	.2545-.2535	R-545
2389881	.253 -.252	R-53

11. Apply sealing compound to surface of washer, lock plate, and bolt before assembly. Install washer (28), lock plate (27), and shaft bolt and tighten bolt to 200-225 ft.-lbs. torque. Bend one side of lock plate against shaft bolt.

12. Install new O-ring (34) in groove in bearing retainer (35). Assembly is now ready to install in housing.

BEVEL GEAR AND BEARING RETAINER INSTALLATION

Key numbers in text refer to figure 67. To facilitate installation, the gear and retainer unit can be cooled and the accessory drive housing can be heated.

> **CAUTION**
>
> IF IT IS FOUND NECESSARY TO HEAT THE ACCESSORY DRIVE HOUSING, APPLY HEAT UNIFORMLY TO HOUSING, OTHERWISE THE CASTING MIGHT FRACTURE. HEAT LAMPS HAVE BEEN FOUND SATISFACTORY FOR THIS PURPOSE.

1. Apply clean (SAE #30) engine oil to outer surface of bearing retainer (8) and over O-ring

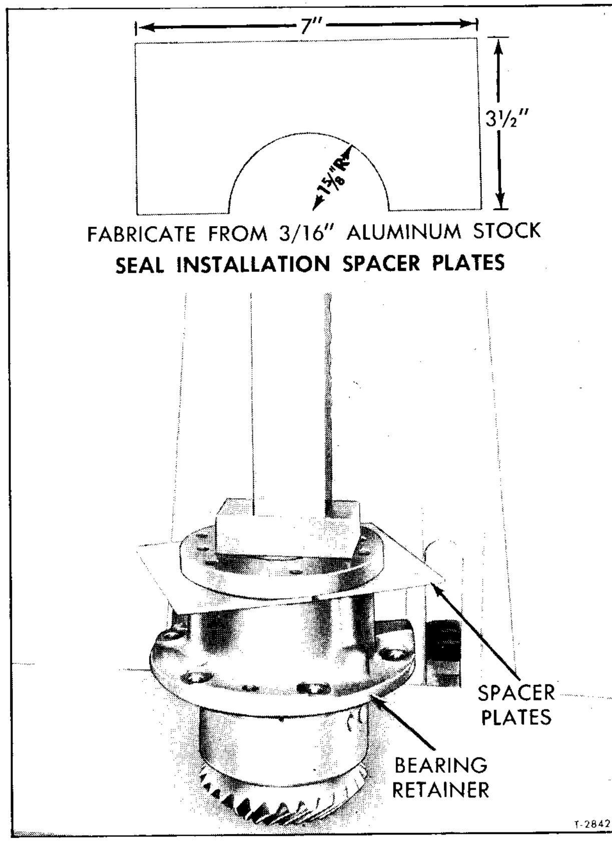


Figure 72—Using Spacer Plates To Install Seal

(10) installed in groove of retainer.

2. Locate same pack of adjustment shims (9) removed originally over retainer, then with dowel pin aligned, insert bearing retainer into accessory drive housing.

3. Use two long bolts, opposing each other, to pull retainer into housing, then install bolts (5) and lock washers attaching bearing retainer to accessory drive housing. Tighten bolts evenly and firmly.

4. Install propeller shaft flange with drive key to bevel gear. Coat flats of flange washer and face of flange nut with oil sealant, then install washer and nut. Tighten nut to 100 to 110 foot-pounds torque.

BEVEL GEAR AND PINION ADJUSTMENTS

Key numbers in text refer to figure 67.

Shims (9 and 37) are available in three thicknesses (0.003", 0.010", and 0.031") for adjustment of backlash and tooth contact of bevel pinion and bevel gear. Figure 67 shows shims installed between accessory drive housing and pinion gear retainer. Whenever assembling accessory drive unit or installing new pinion and bevel gear, or in the event it should become necessary to readjust

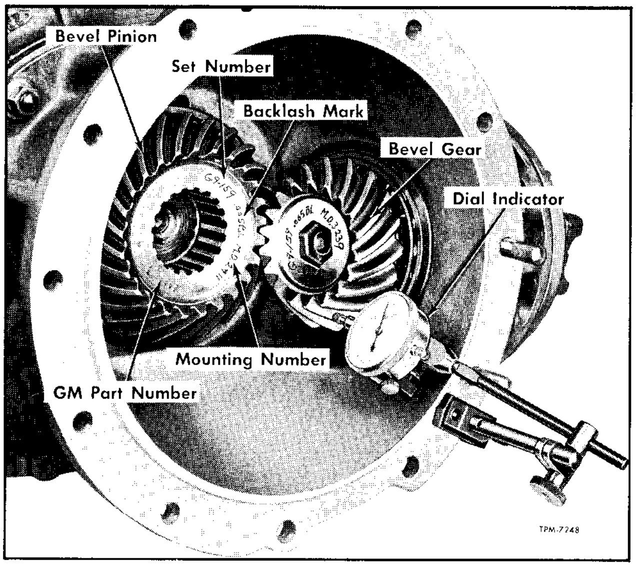


Figure 73—Checking Bevel Gear Backlash

gear backlash because of normal wear, the following operations must be accomplished to properly adjust the pinion and bevel gear backlash.

Backlash dimension is etched on pinion and bevel gear as shown in figure 73.

1. If accessory drive is installed to coach engine, it must be removed as previously directed.

2. Check gear backlash using dial indicator positioned as shown in figure 73. Dimension should be same as etched on gears. Adjustment can be accomplished through shims (9 and 37) provided between bevel gear bearing retainer (8) and accessory drive housing, and between bevel pinion bearing retainer (35) and accessory drive housing. Shims are of 0.003", 0.010", and 0.031" thickness.

3. To check for proper tooth contact, paint several teeth on pinion gear with a mixture of ground red lead and engine oil or a similar marking compound to provide a method of determining tooth contact.

4. Turn bevel pinion in direction of rotation (fig. 67) and observe tooth contact impression on drive side of gear teeth. Contact should start at toe of tooth (View B, fig. 74) and extend back about 80% of tooth length toward heel. Contact should be distributed evenly over flank and face of tooth, indicating center of contact on pitch line. Refer to Views "A" and "B,", figure 74.

a. If tooth contact is too far out on tooth toward heel (View C, fig. 74), decrease thickness of shim pack (9) between bevel gear bearing retainer (8) and accessory drive housing, moving bevel gear toward pinion. Restore backlash by increasing shim thickness (37) between pinion bearing retainer (35) and accesory drive housing. Figure 67 shows shims (37) installed between pinion gear bearing retainer and accessory drive housing.

b. If tooth contact extends from toe appreciably less than 80% of tooth contact (View D, fig. 74), move bevel gear away from pinion by increasing shim thickness (9) between bevel gear bearing retainer and accessory drive housing. Restore backlash by decreasing shim thickness (37) between pinion bearing retainer and accessory drive housing.

c. If tooth contact is low on flank of tooth (View E, fig. 74), move pinion away from bevel gear by increasing shim thickness (37) between pinion bearing retainer and accessory drive housing. Restore backlash by decreasing shim thickness between bevel gear bearing retainer and accessory drive housing.

d. If contact is high on face of tooth (View F, fig. 74), move pinion toward bevel gear by decreasing shim thickness (37) between pinion bearing retainer and accessory drive housing. Restore backlash by increasing shim thickness (9) between bevel gear bearing retainer and accessory drive housing.

5. When pinion and bevel gear adjustments have been completed, make certain that all retainer attaching bolts and nuts are securely tightened. Recheck adjustment. Remove all red lead from gears.

6. Install accessory drive unit in coach.

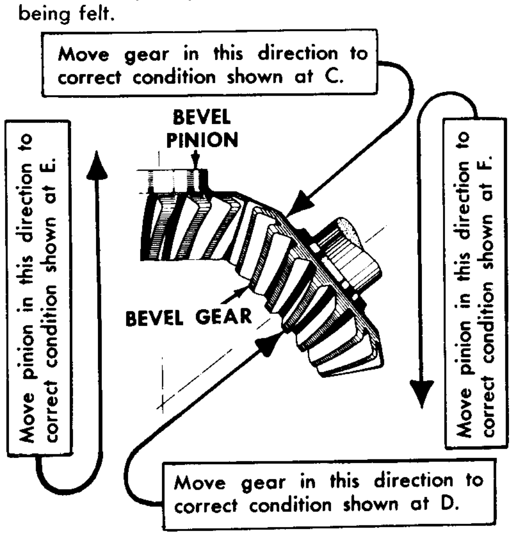
INSTRUCTIONS

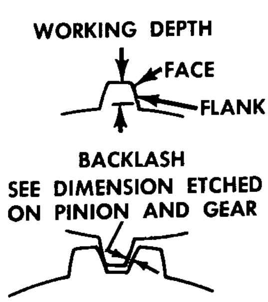
1—Install bevel pinion and bevel gear assemblies; then adjust pinion and bevel gear for proper backlash as directed in "Bevel Gear and Pinion Adjustments" paragraph of this section.

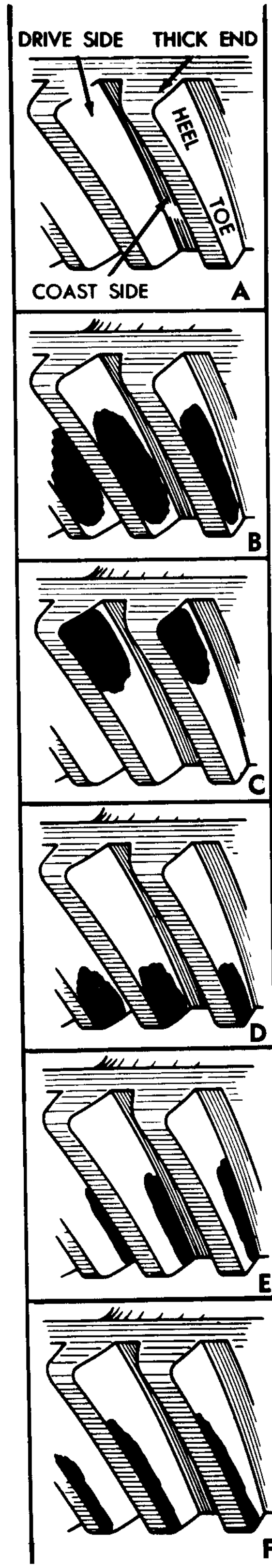
2—Paint three or four teeth of bevel gear with red lead or mechanics blue and rotate bevel gear in direction of rotation until pinion makes complete revolution.

3—Note area of tooth contact which should start at toe and extend about 80 percent of tooth length toward heel, as at B.

4—Vary position of pinion and gear as per chart until proper tooth contact is obtained. Be sure that sufficient backlash has been allowed so that gear can be completely revolved without any highspots being felt.







A—Check adjustments at drive side of BEVEL GEAR tooth

B—Shows correct tooth contact

NOTE: Key Numbers Below Refer to Figure 67

C—Shows short contact at heel. To correct, decrease shim thickness (5) to move gear toward pinion. Then increase shim thickness (19) to move pinion away from gear to again secure correct backlash.

D—Shows short contact at toe. To correct, increase shim thickness (5) to move gear away from pinion. Then decrease shim thickness (19) to secure correct backlash.

E—Shows heavy contact on flank or lower portion of tooth. To correct, increase shim thickness (19) to move pinion away from gear until contact comes to full working depth of gear tooth without breaking contact at flank. Then decrease shim thickness (5) to move gear toward pinion to secure correct backlash.

F—Shows heavy contact on face or upper portion of tooth. To correct, decrease shim thickness (19) to move pinion toward gear until contact covers flank of tooth without breaking contact at face. Then increase shim thickness (5) to move gear away from pinion to secure correct backlash.

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Figure 74—Accessory Drive Bevel Gear and Pinion Gear Tooth Contact Chart

System Services and Tests

CONTENTS OF THIS SECTION

NOTE: General instructions for servicing air conditioning system are located on the back side of compressor compartment door as shown in figure 75. Detail service instructions are explained in this section under respective headings.

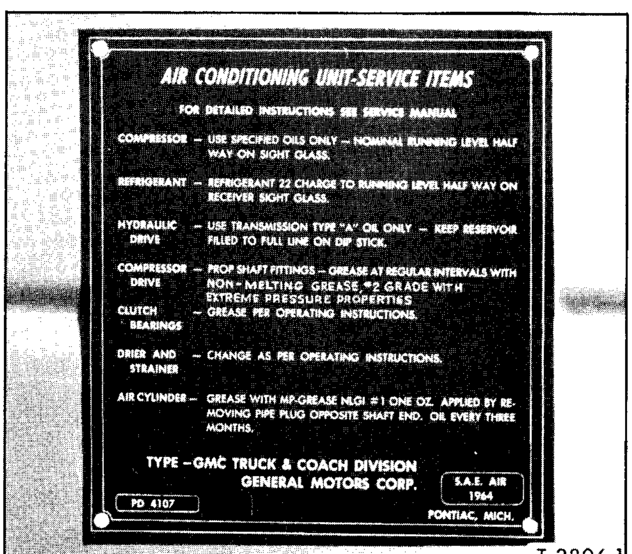


Figure 75—Service Instruction Plate—Located on Inner Side of Radiator and Compressor Door

SERVICING CONDENSER FAN DRIVE FLUID SYSTEM

DRAINING SYSTEM

1. Remove filler cap from fluid reservoir in engine compartment.
2. With a catch basin positioned under line connections at fluid pump mounted on engine, slowly break connections one at a time. Allow fluid to drain into basin.
3. Position a catch basin at condenser cooling fan motor in condenser coil compartment (fig. 13). Slowly break connections one at a time. Allow fluid to drain into basin.
4. After draining system, reconnect lines to fan motor and pump. Do not tighten pump connections firmly at this time.

FILLING SYSTEM

1. Fill reservoir with recommended fluid. System requires approximately 6 quarts.
2. Loosen line connections at pump so lines will vent and fill with fluid. Retighten connections

when all air is expelled.

3. While having assistant maintain fluid level in reservoir, start system and operate fluid pump. Run engine at fast idle speed while filling.

CAUTION: Do not operate without fluid in pump.

4. Make sure all air is expelled from system and fluid in reservoir is to "FULL" mark on dipstick. Check for leaks at all line connections.

5. Install filler cap.

REPLACING FILTER ELEMENT

Procedure for replacing reservoir filter is the same as explained for replacing power steering fluid filter element in "POWER STEERING" (SEC. 16).

CLEANING COILS OF CONDENSER

At regular coach service intervals, check condenser coil external surfaces for dirt or other foreign matter. A clogged coil will cause high refrigerant pressures and insufficient cooling. Remove filter screen and flush from inner side of coil using water, or water mixed with air pressure.

IMPORTANT: DIRECT PRESSURE STRAIGHT THROUGH COIL TO PREVENT BENDING OF FINS AND DO NOT USE EXTREMELY HIGH PRESSURE.

CHECKING REFRIGERANT LEVEL

Since the refrigerant in the system exists in two forms, liquid and vapor, the heat load in the refrigerant will determine the percentage of liquid to vapor. Since the liquid level is used as the indicator of quantity of refrigerant in the system, it follows that heat load must be a considered factor when checking refrigerant level.

Maximum heat load may be imposed by one or more of the following conditions:

1. Opening door and windows.
2. Parking coach in direct sunlight.
3. Placing coach in line with air flow from wall or overhead heater.
4. Using canvas duct to direct heat and/or steam to coach interior.
5. Use coach heating system to increase temperature (engine running at 1000 rpm).

After the system has been subjected to the heat load for 30 minutes, check the fluid level at the receiver sight glass (figure 8). When refrigerant is being added or upon charging after system has been evacuated, the flow should be halted by closing the charging tank supply valve when the liquid appears at the bottom of the sight glass. From the time the refrigerant enters the system until it reaches the receiver, there is a time delay of approximately 2 minutes.

AT NO TIME SHOULD THE LEVEL SHOW MORE THAN HALF WAY UP ON THE SIGHT GLASS.

A full charge of refrigerant will weight from 22 to 24 pounds. In many cases where a nominally empty system is being refilled, less than 24 pounds will be required to obtain the proper level on the sight glass.

Overfilling a system can result in:

1. Liquid slugging the compressor, causing:
   a. Connecting rod damage.
   b. Valve failure.
   c. Clutch failure due to high torque requirements.
   d. Costly repair.
2. Excessive departure of oil from the compressor.

With a system charged to the bottom of the receiver sight glass, the addition of two pounds of refrigerant will raise the level to the middle of the sight glass. From the bottom of the sight glass a charge of five pounds will overfill the receiver. With the level ABOVE the sight glass, the line between the liquid and the vapor is not visible and it would be easy to read this as a LOW condition.

BE SURE YOU KNOW WHERE THE LEVEL IS BEFORE YOU ADD REFRIGERANT. IT IS CONSIDERED UNWISE TO ADD REFRIGERANT IF THE LIQUID LEVEL IS VISIBLE AT THE BOTTOM OF THE SIGHT GLASS, OR HIGHER.

CHARGING THE SYSTEM

ADDING REFRIGERANT TO SYSTEM

NOTE: Before adding any refrigerant to system, make sure all leaks have been repaired. Also level out the system by operating the system for 10 to 20 minutes at approximately 1500 engine rpm.

1. Refer to figure 76, which shows lines and gauge set properly installed. Install gauge set to test gauge fittings as shown.

CAUTION: Valves at compressor should be backseated before removing valve caps and connecting test gauge lines. After connecting lines, open valves 1/4 to 1/2 turn.

Connect refrigerant tank charging line loosely to center fitting of gauge manifold. Purge air from refrigerant supply line, then retighten line fitting.

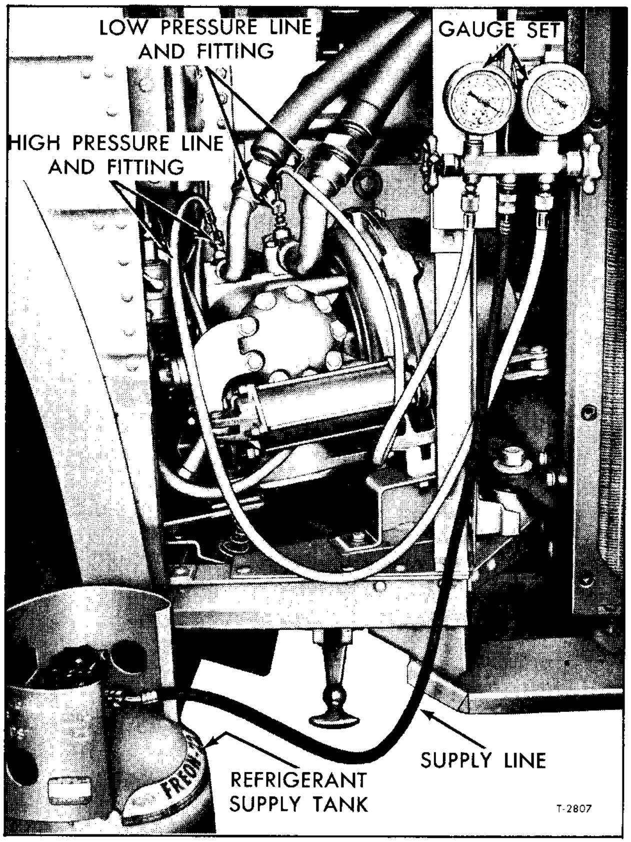


Figure 76—Charging Refrigerant System

2. Open valve on low pressure side of gauge manifold. Make sure valve on high pressure side is closed.

3. Open outlet valve on refrigerant tank. Support refrigerant tank in its upright position and have assistant start and operate system at approximately 1500 engine rpm. Refrigerant will be drawn into system. DO NOT FEED REFRIGERANT TO SYSTEM TOO FAST AS THIS WILL CAUSE OIL TO LEAVE COMPRESSOR. Operate system until refrigerant liquid in receiver tank appears at bottom of sight glass (fig. 13). Check oil level in compressor sight glass. Heat load should be applied during leveling off, so that all oil will return from system to compressor.

4. Close refrigerant tank outlet valve, and remove line and gauge equipment. Install protector caps on test gauge fittings at compressor valves.

CHARGING AN EMPTY SYSTEM

A system which has been evacuated can be charged in same manner described above for "Adding Refrigerant to System." However, if compressor cannot be operated, refrigerant can be transferred from refrigerant tank to system as directed above until refrigerant "HI-LO" pressure switch cuts in and compressor starts to operate. Continue to add refrigerant to system by performing Steps 3 and 4 under "Adding Refrigerant to System."

REMOVING EXCESS REFRIGERANT

(Returning to Supply Tank)

NOTE: To avoid the possibility of removing compressor oil along with the refrigerant by exhausting the refrigerant at gauge service fittings, it is recommended that the refrigerant be exhausted from the top of compressor suction valve. Do not operate system when removing refrigerant.

CAUTION: When transferring refrigerant from air conditioning system to a tank, make sure tank is not filled beyond its rated capacity by weight.

1. Install refrigerant gauge set to test gauge fittings (fig. 76). Make sure gauge valves are closed.

2. An empty or partly empty refrigerant drum should be connected with hose to center fitting of gauge set. Purge air and moisture from connecting hose.

3. Pack refrigerant supply tank in ice or run cold water over tank until temperature of tank is reduced and pressure in tank is maintained well below the pressure in system.

4. Open valve at top of refrigerant supply tank. Slowly open low pressure valve on gauge set and permit refrigerant to enter supply tank. NOTE: The rate of refrigerant removal will be determined by the ambient temperature and by the coolness of refrigerant supply tank.

5. After a short period of time, close valves on gauge set and supply tank, then start and operate system until it levels out (10 to 20 minutes at approximately 1500 engine rpm). Check refrigerant level on receiver tank sight glass as previously instructed under "Checking Refrigerant Level."

6. If necessary, repeat refrigerant removal procedure. If such is the case warm refrigerant supply tank, open valve on supply tank and low pressure valve on gauge set. When refrigerant raises to proper level, close valves on supply tank and gauge set.

7. Shut down system. Disconnect gauge set, install protector caps over test gauge fittings.

PUMPING DOWN THE SYSTEM

In order to accomplish certain operations on the system which necessitate disconnecting refrigerant lines, it is necessary to first pump down the system to prevent appreciable loss of refrigerant. To pump down the system means to pump most of the refrigerant into the liquid receiver tank.

1. Connect gauge set to test gauge fitting as shown in figure 76.

2. Operate compressor for 10 or 15 minutes to permit the system to level out, then with compressor still running, close the discharge valve on the liquid receiver tank by turning the valve stem in until the valve seats.

3. Continue to operate compressor at approximately 1600 engine rpm, until low pressure switch stops it, observing pressure on gauge.

4. When suction pressure builds up to low pressure switch cut-in (30 pounds - after approximately 5 minutes), again start compressor and run until it again cuts out.

5. Close receiver tank and compressor inlet valves by turning clockwise to full "OFF" position.

6. Do not close compressor outlet valve. High pressure test gauge connected to this valve is reading actual pressure of refrigerant in compressor, condenser, and lines leading to and from condenser. This refrigerant cannot be pumped down but must be released before opening the system.

7. Remove center hose from the test gauge set and open valve slowly on high pressure side of set. This will allow remaining refrigerant in the condenser and lines to escape to atmosphere.

8. When indicator on high pressure gauge drops to zero, refrigerant lines on either low or high side may be safely removed. The only unit now containing refrigerant is the sealed-off liquid receiver tank.

> IMPORTANT: If lines to be opened to atmosphere are colder than the ambient air temperature, a considerable amount of sweating will take place on inside of lines. ALWAYS ALLOW REFRIGERANT PIPING AND UNITS TO WARM UP TO THE AMBIENT AIR TEMPERATURE BEFORE OPENING SYSTEM.

EVACUATING THE SYSTEM

Evacuating the system means to place a vacuum on the refrigerant system for the purpose of removing air and moisture. Moisture in system can cause either freezing at the expansion valve or a formation of an acid which is definitely detrimental to the internal parts of compressor. Air in system will cause high head pressure and reduce the cooling capacity.

Whenever the refrigerant system has been opened to a point where moisture and air has been admitted, it is necessary to thoroughly evacuate the system BEFORE RECHARGING.

In case of emergency, where a vacuum pump is not available, system may be blown out with refrigerant to eliminate air in system. This should only be done in an emergency, since considerable refrigerant is used; also a reliable vacuum pump, capable of pulling 28 to 29 inches of vacuum will do a more satisfactory job.

Three different conditions could exist which would determine the method for evacuating the system using a vacuum pump:

1. A condition where an empty system, having no refrigerant at all has been exposed to air and moisture for an extended period of time.

2. A condition where a system in operation has been pumped down with all the refrigerant contained within the receiver tank. This condition could exist if either the high or low pressure side or both sides of system were opened, or exposed.

3. A condition where all the refrigerant has been pumped down only to a point where it is contained in the high pressure side of system such as in the receiver tank, the condenser coil and in the line to the compressor discharge valve. This procedure may be performed at any time when the low pressure side of system has been opened for a short period of time, such as when replacing the evaporator coil or any other unit in the low pressure side of system. When evacuating system later, only the low pressure side of system need be exposed to vacuum.

TO EVACUATE AN EMPTY SYSTEM

1. Using a tee in vacuum line, arrange two vacuum lines from vacuum pump to compressor.

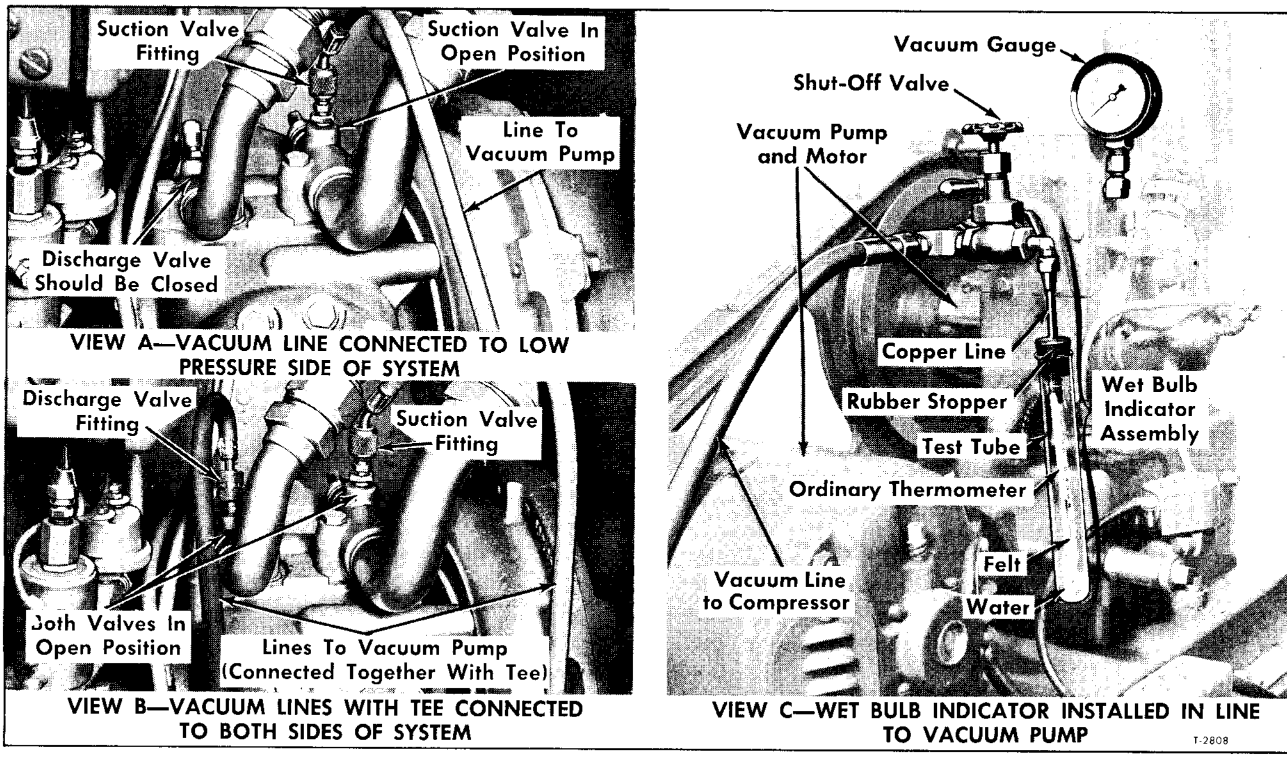
2. Connect one vacuum line to test gauge fitting at top of compressor suction valve, and the other to the compressor discharge valve test gauge fitting as shown in view B, figure 77.

3. Tee a branch line with a wet bulb indicator into vacuum line at pump as shown in view C, figure 77. NOTE: Wet bulb indicator can be improvised from a test tube, a short line, a rubber stopper, a narrow piece of felt (2 in. long) and an ordinary house thermometer.

4. Place all valves (two at receiver tank and two at compressor) in open position.

5. Operate vacuum pump to give maximum vacuum (28 to 29 in.) for at least two hours or until temperature reading on thermometer within indicator registers 35°F. NOTE: Open shut-off valve in branch line to indicator only to read indicator; otherwise keep valve closed during evacuating period.

6. Backseat compressor valves, then disconnect vacuum pump lines from compressor fittings. Install protector caps over fittings. Place compressor valves in open position. System is now ready to be charged.



VIEW A—VACUUM LINE CONNECTED TO LOW PRESSURE SIDE OF SYSTEM

VIEW B—VACUUM LINES WITH TEE CONNECTED TO BOTH SIDES OF SYSTEM

VIEW C—WET BULB INDICATOR INSTALLED IN LINE TO VACUUM PUMP

Figure 77—Evacuating the Refrigerant System

TO EVACUATE AFTER SYSTEM HAS BEEN PUMPED DOWN (All Refrigerant Contained in the Receiver Tank)

NOTE: When system has been pumped down into receiver tank, both the inlet and outlet valves at tank will be closed.

1. Connect same vacuum pump arrangement previously described "To Evacuate An Empty System" (see Steps 1, 2, and 3).
2. Place both the discharge and suction valves at compressor in open position.
3. Pull a vacuum on exposed or open system as directed previously in Step 5 under "To Evacuate An Empty System."
4. After evacuating system, backseat compressor valves, then disconnect vacuum lines. Install protector caps on fittings, then place compressor valves in open position.

TO EVACUATE AFTER SYSTEM HAS BEEN PUMPED DOWN (Refrigerant Contained in the High Pressure Side of System Only)

NOTE: When system was pumped down into the high pressure side of system, the receiver tank outlet valve only was closed and the compressor discharge valve only was closed. Refrigerant is now contained in the receiver tank, the condenser coil, and in the high pressure line to compressor discharge valve.

Evacuate as follows:

1. Connect only one vacuum pump line to the test gauge fitting at top of compressor suction valve as shown in view A, figure 77.
2. Use same vacuum pump and wet bulb arrangement described previously under "To Evacuate An Empty System" (see Step 3).
3. Making sure that compressor suction valve is in open position, evacuate low pressure side of system in same manner as directed previously under "To Evacuate An Empty System" (see Step 5).
4. After complete evacuation of system, backseat compressor suction valve, then disconnect vacuum line. Install protector cap on valve fitting.
5. Place all refrigerant valves (two at receiver tank and two at compressor) in open position.

CHECKING FOR AIR IN SYSTEM

Air in refrigerating system causes excessive head pressures and reduction in cooling capacity. Check for air in system as follows:

1. Connect an accurate pressure gauge to high pressure test gauge fitting.
2. Hang an accurate thermometer near intake side of condenser coil.

3. Allow compressor to stand idle for several hours to allow temperatures of all parts to equalize, then note reading on thermometer and reading on gauge.

4. Compare these figures with figures shown in Pressure Temperature Chart on page 334. If pressure gauge shows a reading of more than 3 pounds higher than pressure shown on chart for the existing temperature, air must be purged from system.

PURGING AIR FROM SYSTEM

If it is determined that air is present in system as previously described under "Checking For Air In System," check the moisture indicator (page 331) to determine if moisture is also present. If moisture is indicated, evacuate the system and recharge with new refrigerant as instructed under applicable headings in this section. If moisture is not indicated, purge air from system as follows:

1. Place refrigerant valves in open position to admit refrigerant to entire system.

2. To purge air from system, loosen line connection at top of condenser coil. After a small amount of refrigerant gas and air has escaped, tighten connection.

3. Recheck for air in system as previously directed.

SUPERHEAT CHECK

Instructions for checking superheat are explained previously under "Expansion Valve" in "SYSTEM MAINTENANCE" section of this group.

TESTING FOR REFRIGERANT LEAKS

Whenever repairs or adjustments have been made to any part of the refrigerating system which necessitate disconnecting refrigerant lines, connections should be tested for leakage before the system is restored to service. First admit only enough gas into the system to produce 5 or 10 pounds pressure, then test for leaks (fig. 78), using leak detector explained below. If no leaks are found at this pressure, increase pressure 5 or 10 pounds, and test for leaks again. In this way, only a slight amount of refrigerant gas will be lost in the event there is a leak. Final test should be made with system under operating pressure. Large leaks will be indicated by oil seepage and must be repaired immediately.

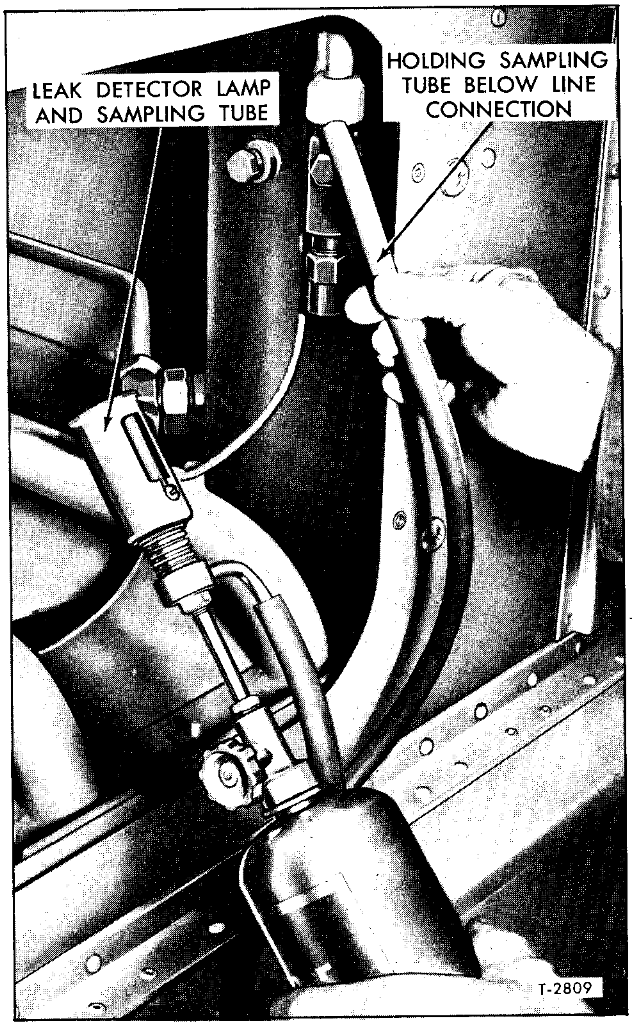


Figure 78—Testing for Refrigerant Leaks

REFRIGERANT LEAK DETECTOR

Refrigerant leak detector, commonly called a Halide Lamp, is a small torch which burns methyl alcohol. Air used in burner is drawn through a flexible sampling tube. Operation of leak detector is as follows:

Pressure is produced in the lamp fuel tank by heat of generation at time alcohol is burned in small cup under burner. Observe color of flame when clear air is being drawn through the sampling tube. Color of flame may vary depending on type and grade of alcohol used in burner.

By holding open end of sampling tube under connections, joints, valves, etc. (fig. 78), any traces of refrigerant would be drawn through the tube to the burner and would be immediately evident by the change in color of the flame. Refrigerant breaks down when coming in contact with the heated copper ring in burner and changes the

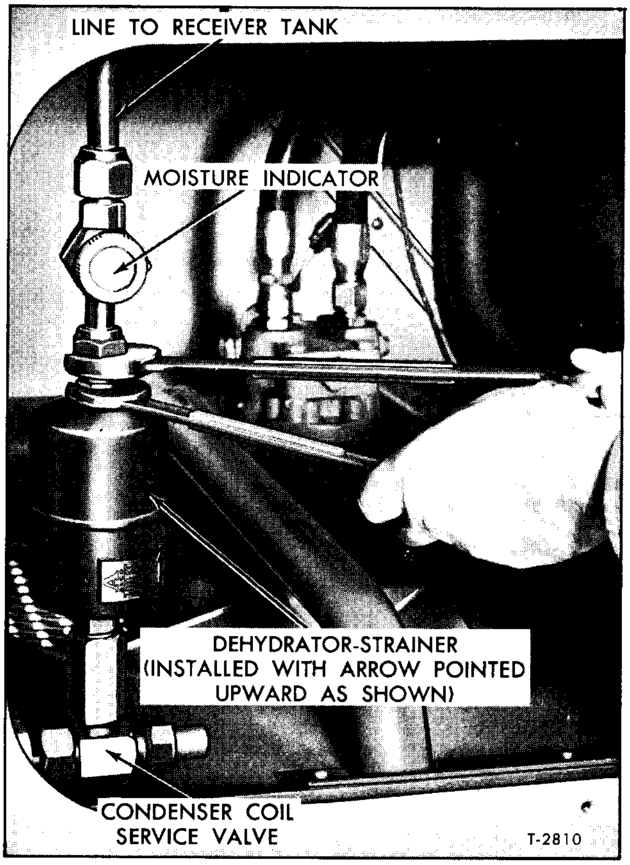


Figure 79—Replacing Dehydrator—Strainer

color of the flame. Do not confuse change in color with change caused by shutting off air supply in holding end of sampling tube too close to some object.

NOTE: Compressor crankshaft seal can be checked for leakage by inserting end of detector tube into hole at bottom of clutch housing when compressor is not operating.

> Instructions are supplied with leak detector and should be carefully studied. Only high grade Anhydrous Methyl Alcohol as listed under "EQUIPMENT AND MATERIALS" at end of this group should be used in burner.

Leak detectors which burn acetylene gas are also available and may be used.

When refrigerant has been lost, adding refrigerant without knowing cause or location of leak merely postpones corrective measures and increases maintenance costs. At two or three week intervals, go over entire system with leak detector. Check for leaks at all joints and connections throughout the system.

REPLACING DEHYDRATOR-STRAINER

Replace dehydrator-strainer as follows:

1. Close receiver inlet and condenser coil service valves (fig. 13). Loosen exhaust port cap.
2. Referring to figure 79, remove old unit in manner shown.

CAUTION: Do not twist refrigerant lines, use two wrenches as shown.

3. Remove old unit from refrigerant line, then remove sealing caps from new unit and IMMEDIATELY thread unit into liquid line. Tighten connections firmly.
4. Remove exhaust port cap on receiver inlet service valve (fig. 13), then open condenser coil service valve, leaving inlet service valve closed.
5. Start air conditioning system and allow refrigerant to exhaust through exhaust port inlet service valve until operator is satisfied that all contaminated refrigerant has been exhausted from between the two valves.
6. Install cap on receiver inlet service valve and tighten firmly, then open inlet service valve (fig. 13).
7. With system operating, test for leaks at connections, using a Halide Torch. Refer to "Testing For Leaks" explained previously.

REFRIGERANT VALVES

Before operating air conditioning system after storage or inactive period and during operation of system, refrigerant valves must be in "Open Position." When system has been pumped down and is being prepared for operation, open valves in the following sequence:

1. Receiver Tank Liquid Out Valve - Fully Open. Stem turned counterclockwise.

2. Compressor Suction Valve - Fully Open (Back Seated), then turn off from backseated position 1/4 - 1/2 turn.

3. Compressor Discharge Valve - Fully Open (Back Seated), then turn off from backseated position 1/4 - 1/2 turn.

4. Receiver Tank Inlet Valve - Fully Open.

SERVICING COMPRESSOR OIL CHARGE

The initial charge of oil in the compressor is 4-2/3 pints. Oil level in compressor is observed through sight glass at side of compressor. Oil level should be checked immediately after system has been in operation at approximately 1500 engine rpm for 45 to 60 minutes. Level should be 1/3 to 1/2 way up on sight glass.

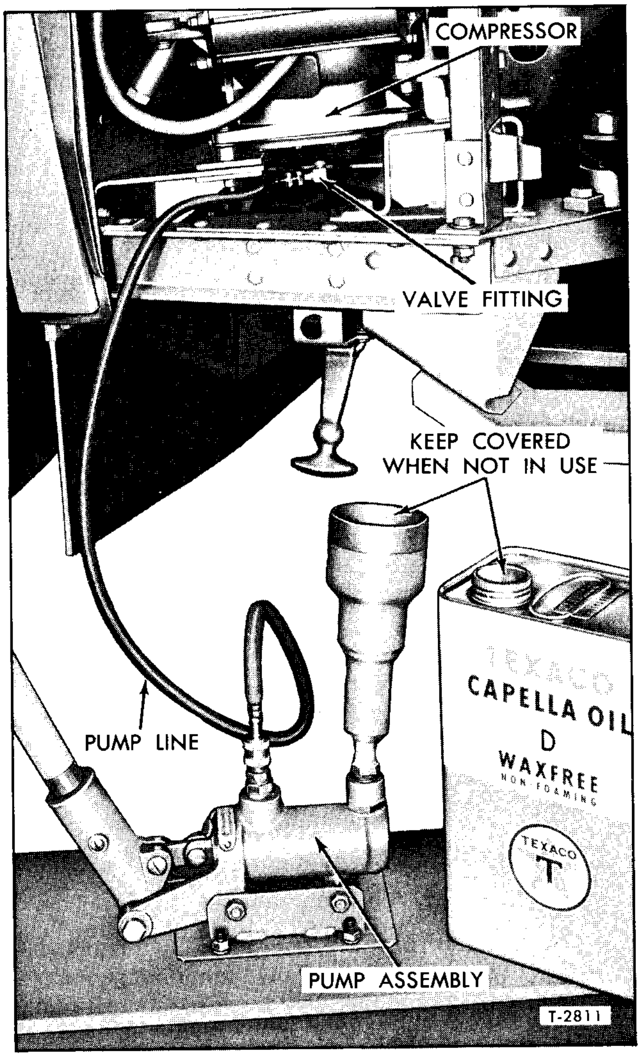


Figure 80—Adding Oil to Compressor Using Hand Pump

If oil is to be added, use special wax-free dehydrated refrigerant type oil having a viscosity equivalent to SAE 10. This oil is readily available through major oil companies. Oil should be obtained in sealed cans. Never use oil which has been exposed to air for any length of time.

ADDING OIL TO A CHARGED SYSTEM

Method Using Portable Hand Pump

NOTE: Compressor oil is added to compressor by means of a pump connected to valve at bottom of compressor as shown in figure 80.

With system leveled out (system operated for 45 to 60 minutes at approximately 1500 engine rpm) add oil as follows:

1. Stop compressor, then remove protector caps from valve stem and line fitting at bottom of compressor.

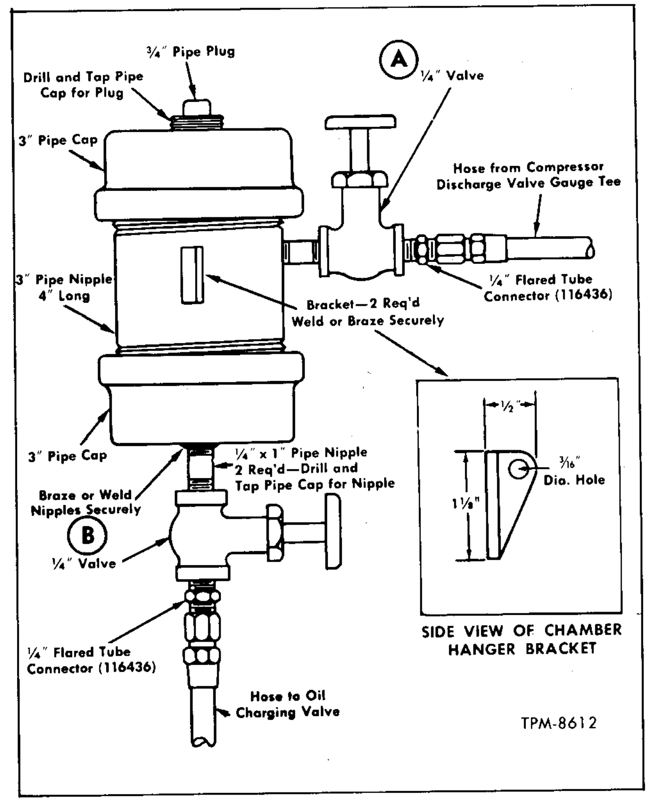


Figure 81—Fabricated Chamber for Adding Oil to Compressor

2. Connect pump supply line loosely to valve fitting. Fill reservoir of pump with recommended oil, then after all air bubbles have vanished, operate pump to purge air from line to compressor valve. Tighten connection at compressor valve.

3. Open compressor valve by turning stem counterclockwise.

4. Operate pump SLOWLY while checking oil level on compressor sight glass.

IMPORTANT: Keep pump reservoir near full at all times to prevent air from being pumped into system.

Add oil until level is 1/3 to 1/2 way up on sight glass. Close valve at base of compressor, then remove charging equipment.

5. Install protector caps over stem and line fitting of compressor valve.

Method Using Fabricated Oil Pressure Chamber

If a portable hand oil pump is not available, oil can be added with a pressure chamber as described below:

Figure 81 illustrates a chamber which can be fabricated locally using readily available parts. It is easy to visualize many other methods of constructing such a chamber, however, the general principles of the one shown in figure 81 should be followed.

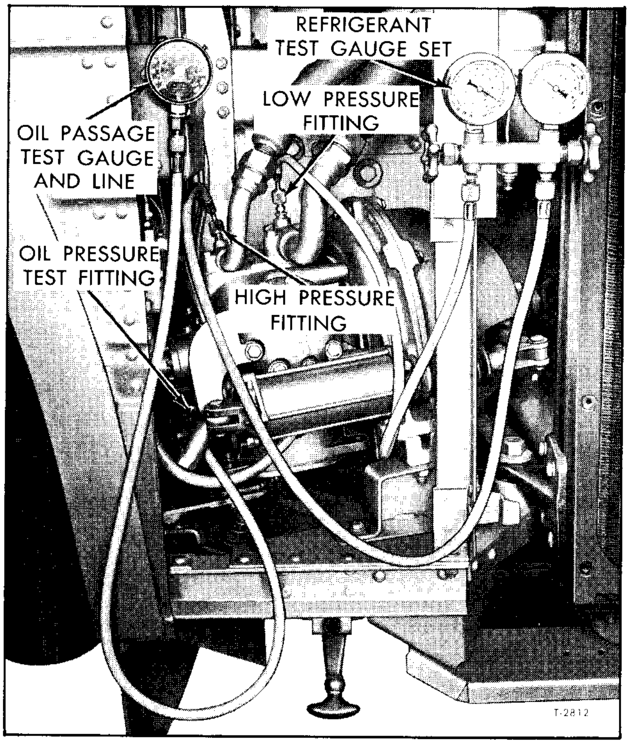


Figure 82—Checking Compressor Pump Pressure

Use chamber as follows:

1. Close both valves ("A" and "B," fig. 81) on oil chamber.

2. Fill the chamber with recommended oil. Hold chamber upright while filling. BE SURE CHAMBER IS COMPLETELY FILLED WITH OIL AND THAT NO AIR IS ENTRAPPED. Install filler plug and tighten firmly.

3. Backseat compressor discharge valve, then connect a hose of sufficient length from upper valve ("A," fig. 81) of oil chamber to test gauge fitting at top of compressor discharge valve. Connect another hose from lower valve ("B," fig. 81) of oil chamber to oil charging valve at top of compressor.

NOTE: Before removing the cap from oil charging valve, make sure the valve is closed. Leave both hose connections loose at the oil chamber valves until air is purged from the hoses.

4. Turn compressor discharge valve stem 1/2 to 1 turn away from the backseated position. Tighten hose connection at side of chamber after a slight amount of gas has escaped. Repeat this operation at the oil charging valve and hose. Leave the discharge valve and the compressor oil charging valve in operating or open position.

5. Start air conditioning system and operate until system has leveled out.

6. Open both valves on pressure chamber, then watch oil level in compressor sight glass. When oil level is 1/3 to 1/2 way up on compressor sight glass, quickly close chamber valves. Backseat the compressor discharge valve and close the oil charging valve at hose of compressor.

7. Disconnect hoses from compressor. Install caps over compressor fittings.

8. Place compressor valves in operating position.

DRAINING EXCESS OIL FROM COMPRESSOR

NOTE: Compressor should be operated for at least 1/2 hour before draining to allow separation of oil and refrigerant.

1. Remove protector caps from stem and line fitting of valve located at bottom of compressor.

2. Connect flexible hose to valve fitting, then open valve slowly by turning stem counterclockwise. Allow oil to flow into suitable container.

NOTE: Special care should be taken when removing oil because of oil foaming. The foaming makes it difficult to determine the amount of oil being removed. Recheck compressor oil level. Close the valve and install protector caps after draining.

CHECKING COMPRESSOR OIL PUMP PRESSURE

To assure proper operation of the compressor, the compressor oil pump must supply the proper oil pressure. The compressor oil pump pressure check is made by subtracting the refrigerant suction pressure reading from the pump pressure reading. The minimum oil pressure reading allowable on pump gauge is 30 psi at 700 rpm engine speed.

<u>Make Check as Follows:</u>

1. Connect refrigerant test gauge to low pressure test gauge fitting (fig. 82). NOTE: For this particular check it is not necessary to connect the gauge set high pressure line to compressor discharge or high pressure fitting as shown.

2. At side of compressor, install oil pressure gauge and hose to compressor oil pressure gauge fitting as shown.

3. Start engine and operate system for 5 to 20 minutes, then check refrigerant suction pressure reading and the pump pressure reading while system is still operating. If refrigerant suction reading is 35 and the oil pump pressure reading is 60, subtract 35 from 60 which leaves 25 psi, the actual pump pressure. If oil pump pressure is below minimum specified, replace

compressor pump. The compressor will fail to function properly unless sufficient oil pressure is available.

CONDENSER FAN SPEED CHECK AND ADJUSTMENT

1. Using a tachometer, check speed of fan which should be not less than 1600 rpm when oil in system is hot and engine is operating at 1650 rpm.

2. If speed is less than specified, assuming that sufficient fluid exists in system, it is an indication that the relief valve piston at fan motor is not seating properly, or that either the pump or motor is defective. Piston spring may not have proper tension to allow pressures to level off above 2000 psi. Also, small particles of dirt under piston may be obstructing the seating of piston.

3. Small round shims can be added or removed from between relief valve piston spring and the base of valve hex head plug. The adding of shims will increase the setting at which the pressures will level off.

NOTE: Before plug is removed for adding or removing shims it is necessary to drain fluid from this end of system. When reassembled, fluid must be refilled to recommended level.

Trouble Shooting

Most any trouble in the air conditioning system will produce the same symptoms - insufficient cooling.

The following, which is more of a quick reference chart, deals with locating and correcting the common causes of insufficient cooling.

NOTE: Detail trouble shooting information of a specific condition, the possible causes of a condition, its symptoms and the recommended action to be taken is shown later on "Trouble Analysis Chart" page 389.

IMPORTANT

THE MOST COMMON CAUSE OF INSUFFICIENT COOLING IS A DIRTY, CLOGGED CONDENSER COIL. THIS CONDITION SHOULD BE CHECKED FREQUENTLY AND CORRECTED AS EXPLAINED ON PAGE 379.

CONDITION	REMARK
1. Underfloor Blower Not Running	
(a) Loose Electrical Connections	Tighten
(b) Defective Relay	Replace Page 328
(c) Defective Blower Motor	Repair
2. Dehydrator - Strainer Clogged	Replace - Page 384
3. Underfloor Air Filter Screen Clogged	Page 313
4. Compressor Valves Not in Operating Position	Page 347
5. Improper Engine Idle Speed	
6. Low Refrigerant	
(a) Leaks in System	Page 383
(b) Recharge System	Page 379
7. Expansion Valve Inoperative	
(a) Capillary Tube Broken	Page 331
(b) Equalizer Tube Restricted	Page 331
(c) Gummed Cage	Page 331
(d) Check for Proper Superheat	Page 331
(e) System Short of Capacity	See "Trouble Analysis Chart" - Page 389
8. Compressor Clutch Disengaged or Fails to Engage	
(a) Dirty Condenser	Page 379
(b) Insufficient Fluid in Condenser Fan Drive System	Page 378
(c) Too Much Refrigerant	Page 380
(d) Air in Refrigerant System	Page 383
(e) Insufficient Air Pressure for Clutch Operation	Page 361
(f) Air Leaks in Clutch Operating System	Page 361
(g) Worn Clutch Plates	Replace - Page 365
(h) Refrigerant Valves Not in Operating Position	Page 347
(j) Dehydrator-Strainer Plugged	Replace - Page 384
(k) Defective Clutch Control Air Cylinder	Page 369
(l) Defective Clutch Control Air Solenoid Valve	Page 329
(m) Faulty Clutch Adjustment	Page 362
9. Compressor Clutch Disengages or Fails to Engage at High Outside Temperatures (Items a, b, and c above will cause this condition.)	

TROUBLE ANALYSIS CHART

This Trouble Analysis Chart is to supply information for trouble-shooting a specific condition, affected mostly by the operation of the refrigerant compressor. It also contains information on conditions affecting pressures within the refrigerant system.

CONDITIONS OR COMPLAINTS

NOTE: Reference note numbers listed under each specific condition or complaint refer to information on the possible causes, the symptoms, and also recommendations for making correction. See designated notes below:

Compressor Fails to Start
(See NOTES: 1, 2, 3, 4, 5, 6 and 7)

Compressor "Short Cycles"
(See NOTES: 8, 9, 10, 11, 12, 13, 14 and 15)

Compressor Loses Oil
(See NOTES: 14, 16, 17, 18, 19, 20 and 21)

Compressor is Noisy
(See NOTES: 16, 19, 22, 23, 24, 25 and 26)

Refrigerant Discharge Pressure Too High
(See NOTES: 12, 15, and 30)

Refrigerant Discharge Pressure Too Low
(See NOTES: 13, 31, and 32)

Refrigerant Suction Pressure Too High
(See NOTES: 25, 32, 33, 34, 35 and 36)

Refrigerant Suction Pressure Too Low
(See NOTES: 11, 13, 14, 37, 38, and 39)

System Short of Capacity
(See NOTES: 11, 14, 25, 27, 28, and 29)

NOTES

	Possible Cause	Symptoms	Recommendations	Reference
NOTE 1	Frozen compressor due to locked or damaged mechanism.	Compressor is noisy or will not operate.	Overhaul compressor.	See page 352
NOTE 2	Broken or sheared compressor drive shaft.	Excessive noise at engine or compressor not operating.	Repair or properly connect drive shaft.	See page 364
NOTE 3	Clutch drive plate is worn or saturated with grease.	Slipping action. Odor or smoke in compart. ment.	Replace clutch plate. Check and adjust clutch control air cylinder push rod travel.	See page 365
NOTE 4	Defective clutch control air cylinder or improper linkage adjustment.	Slipping action. Odor or smoke in compartment.	Check and adjust air cylinder push rod travel.	See page 362
NOTE 5	Insufficient air pressure for clutch operation.	Slipping clutch. Odor or smoke in compartment.	Build up at least 65 psi in air system. Check pressure to air cylinder.	See page 361
NOTE 6	Defective clutch control air solenoid valfe.	Clutch fails to engage.	Check for open circuit to valve. Loose connections. Defective valve.	See page 329

TROUBLE ANALYSIS CHART (CONT'D)

	Possible Cause	Symptoms	Recommendations	Reference
NOTE 7	Open control circuit. a. Hi-Lo pressure switch defective. b. Engine oil pressure too high (over 15 psi). c. Engine idling too fast (above 600 rpm).	Open circuit to clutch solenoid valve.	Lower engine idling speed. Engine oil pressure must be below 15 psi. Oil may be cold. Check "HI-LO" pressure switch setting.	See page 326
NOTE 8	Intermittent contact in electrical control circuit. Compressor valves not in operating position.	Compressor intermittently starts and stops.	Repair or replace faulty electrical control. Check for loose wiring connections. Open compressor valves.	See page 347
NOTE 9	Low pressure switch controller differential set to close.	Frequent starting and stopping.	Check Hi-Lo pressure switch setting.	See page 326
NOTE 10	High pressure switch controls differential too close.	Frequent starting and stopping.	Replace Hi-Lo pressure switch assembly.	See page 326
NOTE 11	Dirty or iced evaporator coil.	Reduced air flow: a. Dirty or clogged air filter screen. b. Underfloor blower inoperative. c. Plugged recirculating air ducts.	Clean air filter screen. Check recirculating ducts for obstructions. Check blower motor.	See page 313 See page 313
NOTE 12	Overcharge of refrigerant or noncondensible gas.	High discharge pressure	Remove excess refrigerant or purge system.	See page 380 See remark No. 7 later.
NOTE 13	Lack of refrigerant.	Too frequent starting and stopping on low pressure control switch.	Repair refrigerant leak and recharge system.	See remark No. 6 later.
NOTE 14	Clogged refrigerant dehydrator-strainer.	Suction pressure too low and frosting at strainer unit.	Replace dehydrator-strainer.	See page 384
NOTE 15	Faulty operation of refrigerant condensing system.	Compressor cuts off and on from high pressure switch. a. Condenser fan motor or pump inoperative. b. Condenser air inlet or exhaust grille obstructed. c. Condenser coil dirty.	Repair or replace. Remove obstruction. Clean coil.	See page 337 See page 379
NOTE 16	Insufficient oil.	Oil level too low.	Add proper amount of compressor oil.	See page 347

TROUBLE ANALYSIS CHART (CONT'D)

	Possible Cause	Symptoms	Recommendations	Reference
NOTE 17	Traps in hot gas and suction lines.	Oil level gradually drops.	Recheck lines for possible traps. Lines may have been repositioned when body repairs were made.	See remarks Nos. 1 and 5 later.
NOTE 18	Loose expansion valve remote bulb.	Excessive cold suction line.	Provide good contact between remote bulb and suction line.	See remark No. 2.
NOTE 19	Liquid flooding back to compressor.	Excessive cold suction line. Noisy compressor operation.	Readjust superheat setting and check remote bulb contact.	See remarks Nos. 2 and 4 later.
NOTE 20	Short cycling.	Frequent starting and stopping of compressor.	See items previously under "Compressor Short Cycling."	
NOTE 21	Compressor leaking oil.	Oil around base and low oil level on sight glass.	Repair oil leak and add proper refrigerant oil.	See page 352
NOTE 22	Loose compressor drive shaft.	Flange nuts loose.	Tighten bolt nuts.	See page 364
NOTE 23	Dry or scored compressor crankshaft seal.	Squeak or squeal when compressor is running.	Check oil level. Replace compressor seal.	See page 352
NOTE 24	Internal parts of compressor broken.	Noisy compressor.	Overhaul compressor.	See page 352
NOTE 25	Expansion valve stuck in open position.	Abnormal cold suction line. Compressor knocks.	Repair or replace expansion valve.	See remark No. 2 later.
NOTE 26	Compressor hold-down mountings loose.	Compressor vibrates excessively.	Tighten or replace mountings.	See page 347
NOTE 27	Flash gas in liquid line.	Expansion valve hisses.	Add refrigerant.	See remark No. 6 later.
NOTE 28	Excessive pressure drop in evaporation.	Superheat too high.	Check superheat and reset expansion valve.	See remark No. 4 later.
NOTE 29	Improper superheat adjustment.	Short cycling.	Adjust expansion valve.	See remark No. 4 later.
NOTE 30	Air or non-condensible gas in system.	Exceptionally hot condenser and excessive discharge pressure.	Purge system.	See remark No. 8 later.
NOTE 31	Broken or leaky discharge valves within compressor.	Suction pressure rises faster than 5 lbs. per minute after pressure shut-down.	Remove compressor head, examine valves and if necessary, replace.	See remark No. 9 later.

AIR CONDITIONING

TROUBLE ANALYSIS CHART (CONT.)

	Possible Cause	Symptoms	Recommendations	Reference
NOTE 32	Leaky relief valve in compressor.	Insufficient cooling.	Replace relief valve.	See page 352
NOTE 33	Excessive load on evaporator.	Insufficient cooling.	Check for leaks in evaporator compartment. Check air filter screen and blower motor.	
NOTE 34	Overfeeding of expansion valve.	Abnormally cold suction line. Liquid flooding back to compressor.	Check contact of expansion valve remote bulb in suction line well.	See remarks Nos. 4 and 5 later
NOTE 35	Broken suction valves within compressor.	Noisy compressor.	Remove compressor head, examine valves and if necessary, replace.	See remark No. 9 later
NOTE 36	Compressor worn.	Insufficient cooling.	Overhaul compressor.	See page 352
NOTE 37	Expansion valve power unit has lost charge.	No flow of refrigerant through valve.	Replace expansion valve assembly.	See remark No. 3 later
NOTE 38	Obstructed expansion valve.	Loss of capacity.	Clean or replace expansion valve.	See page 331
NOTE 39	Too much pressure drop through evaporator coil.	Superheat too high.	Check for plugged external equalizer line at expansion valve.	See page 331

TROUBLE ANALYSIS CHART REMARKS

REMARK NO. 1 CLOGGED REFRIGERANT DEHYDRATOR-STRAINER (Refer to Fig. 13)

Occasionally the dehydrator-strainer in the liquid line may become clogged with foreign material in the system. When this happens, the liquid line leaving the strainer will feel cooler than the liquid entering. If it is badly clogged, some sweat or frost may appear at strainer outlet.

REMARK NO. 2 REFRIGERANT EXPANSION VALVE STUCK IN OPEN POSITION (Refer to Figs. 9, 10, and 12)

If the expansion valve is stuck in an open position, there will be an excessive amount of sweating on the suction line and compressor crankcase due to the large amount of liquid being passed into the suction line.

REMARK NO. 3 REFRIGERANT EXPANSION VALVE HAS LOST CHARGE (Refer to Figs. 9, 10, and 12)

The power element of expansion valve consists of the remote bulb, capillary tube and the diaphragm, which actuates the valve cage. If this power element is inoperative or has lost its charge, the valve will either maintain an almost closed position or may close completely. Test for an inoperative power element as follows:

a. Stop compressor.
b. Remove remote bulb from well in suction line at end of evaporator coil.
c. Carefully place remote bulb in container filled with ice water.
d. Start compressor.
e. Remove remote bulb from ice water and warm in hand. At the same time check suction line for rapid temperature change which indicates flood-through of liquid refrigerant. If refrigerant floods through valve, power unit is operating properly.

WARNING: Do not flood-back through suction line for too long a period as excessive liquid flood-back could cause severe damage to compressor.

TROUBLE ANALYSIS CHART REMARKS (CONT'D)

REMARK
NO. 4 - REFRIGERANT EXPANSION VALVE IMPROPERLY ADJUSTED (Figs. 9, 10, amd 12)

If the expansion valve is adjusted for too low a superheat, too much liquid will be passed into evaporator. The suction line will be normally cold and liquid may slug back to the compressor. If expansion valve is adjusted for too high a superheat, too little liquid will be passed to the evaporator and the suction line will be abnormally warm. Superheat must always be adjusted carefully using thermometer (fig. 12) and suction gauge.

REMARK
NO. 5 - REFRIGERANT EXPANSION VALVE IS OBSTRUCTED (Refer to Figs. 9 and 10)

Foreign material may obstruct the valve port. If the obstruction is small, the resulting operation will be a "hunting" condition which will cause a suction pressure variation of possibly 10 to 15 psi on suction pressure test gauge. If the obstruction is large and only a small trickle of liquid can pass, the compressor will short cycle. If the obstruction holds the valve open during shutdown, liquid will flood back to compressor. This causes liquid slugging to compressor at start-up, which is definitely harmful. Compressor will knock when this occurs. An obstructed expansion valve is usually indicated by a partly warm evaporator and frosting at the evaporator inlet.

REMARK
NO. 6 - SHORTAGE OF REFRIGERANT

There should always be sufficient liquid in the receiver tank (1/2 way up on sight glass) to completely submerge the inlet to the liquid line pipe. If there is a shortage of refrigerant, the liquid level will fall below the inlet to the liquid line and a mixture of gas and liquid will pass into the liquid line. Bubbles will appear in the sight glass, the larger the bubbles the more severe the refrigerant shortage. Frequently there will be a hissing or whistle at the expansion valve. The coil and suction line will be relatively warm while the suction pressure will be low due to little or no liquid being supplied to the evaporator if the shortage is severe.

REMARK
NO. 7 - OVERCHARGE OF REFRIGERANT

An overcharge of refrigerant will cause high head pressure. Liquid will back up in the condenser and decrease the amount of surface available for condensing and as a result the head pressure will rise. In extreme cases, it may rise to a point where the high pressure cut-out switch will stop the compressor. This may result in compressor short cycling.

REMARK
NO. 8 - AIR IN SYSTEM, PURGING

If air or non-condensible gases are present in the system, they will usually tend to move toward and collect at the condenser. The head pressure will rise to a point above the pressure corresponding to the temperature at which the vapor is condensing. In extreme cases, the pressure may rise to a point where high pressure cut-out switch will stop the compressor.

To determine whether or not there is air in the system, the compressor must be allowed to stand idle long enough for the entire system to cool down to the temperature of the surrounding air. After the system has attained the same temperature as the surrounding air, the reading of the head pressure test gauge should not be more than 12 lbs. above the saturation pressure corresponding to the surrounding air temperature. See "Refrigerant, Pressure-Temperature Relationship" chart, page 334.

REMARK
NO. 9 - BROKEN VALVES IN COMPRESSOR

Broken suction valves or broken or leaky discharge valves within the compressor are generally indicated by the suction pressure rising rapidly as soon as the compressor is stopped. If the suction pressure rises faster than 5 lbs. per minute, it is an indication that the compressor discharge valves are not holding. Before the compressor is torn down, however, it should be determined that the pressure rise is not due to a leaky expansion valve.

Air Cond. Lubrication and Inspection

The following tabulation lists lubrication and service points, service required, and the recommended intervals at which these services should be accomplished. These services should be accomplished at more frequent intervals when system is operated under severe conditions such as extremely high temperatures. References in right-hand column refer to page numbers where service procedures are covered, or to Lubrication Notes below for recommended lubricant and proper application.

Item	Service Required	Daily	At Inspection	See Footnote	Refer to
Compressor	Check Oil Level - Add if Required	X			Page 384 (Note 1 below)
	Drain and Refill			(A)	--
	Check Tightness of Mounting Bolts		X		--
Compressor Suction and Discharge Valves	Check Tightness of Mounting Bolts and Valve Caps		X		--
Liquid Receiver Tank	Check Refrigerant Level	X			Page 379
	Check Tightness of Mounting Bolts		X		--
Condenser	Clean Coils as Necessary	X			Page 379
Dehydrator Strainer	Replace			(B)	Page 384
Underfloor Air Filter Screens	Clean and Re-oil		X		(Note 2 below)
Evaporator Coil	Clean		X		Page 335
Hi-Lo Pressure Switch	Check Adjustment		X		Page 326
Driver's Control Panel	Tighten Connections		X		--
Condenser Fan Fluid Drive	Check Oil Level - Add if Required		X		Page 378 (Note 3 below)
Compressor Drive Propeller Shaft	Lubricate with Hand Gun		X		(Note 4 below)

(A) After initial 200 hours of operation. (B) Whenever system has been opened.

NOTE 1—COMPRESSOR OIL

A special wax-free dehydrated refrigerant type oil having a viscosity about the equivalent of S.A.E. 10 must be used. This oil is readily available through major oil companies. Approved oils are: Cities Service Oil Company - Trane 1001; Ansul 300 non-foaming; Standard Oil of Indiana - LM Industrial Oil #32-P. Oil should be obtained in sealed cans. Never use bulk oil or oil which has been exposed to air for any length of time. Drain and refill after first 200 hours of operation. After this change only at overhauls. The compressor capacity is 4-2/3 pints.

NOTE 2—ODORLESS OIL

Air Filter Screens. Thoroughly clean filter screens, then spray, or dip and let drain, with light odorless oil, such as medicinal white oil. (Do not oil condenser filter.)

NOTE 3—HYDRAULIC FLUID

Condenser Fan Drive System. Use Type "A" Automatic Transmission Fluid bearing the qualification letters "AQ-ATF." System capacity is 5 quarts. IMPORTANT: Keep fluid container covered while not in use.

NOTE 4—GEAR OIL

Compressor Drive Shaft Universal Joints. Apply small quantity of Non-Melting Grease, #2 Grade with extreme pressure properties to three fittings at 3,000 mile intervals. OVER-LUBRICATION AT FRONT FITTING WILL DAMAGE CLUTCH.

Equipment and Materials

The following equipment and materials are required for servicing the Air Conditioning System. This equipment and material can be procured locally or from any reliable air conditioning or refrigeration supply house.

EQUIPMENT

Thermometer with Remote Reading Dial - For use in conjunction with expansion valve adjustment.

Soldering Torch and Cylinder of Gas - For soldering refrigerant line fittings.

Oil Pressure Gauge - For checking compressor oil pump pressure.

Leak Detector - For detecting refrigerant leaks.

Vacuum Pump and Gauge - For evacuating the system. Should be capable of pulling 28 to 29 inches of mercury vacuum.

Test Gauge Fitting Hose Adapters - For adapting service refrigerant hoses to gauge fittings (J-9459 Adapter and J-12148 Adapter Gasket).

Wet Bulb Indicator - For checking amount of air and moisture in system while evacuating system.

Hand Oil Pump - For adding oil to a charged system.

Pressure and Vacuum Gauge Set - For checking Refrigerant-22 system operation.
- With combination vacuum air pressure gauge
  - 0 to 30" vacuum scale.
  - 0 to 150 lbs. pressure scale.
- With high pressure gauge - 0 to 400 lbs. scale.

MATERIALS

Anhydrous Methyl Alcohol - For use in leak detector.

Refrigerant 22 - Monochlorodifluoromethane. Do not use any other type of refrigerant in this system. (Approximately 23 lbs. required in system, available in 22 and 100 lb. cans.)

Solder - 95% tin and 5% antimony - For soldering refrigerant line fittings.

Nokorode Soldering Paste - For use on soldered fittings.

Refer to next page for Specifications.

Specifications

COMPRESSOR
- Make....Trane
- Model....G7B20
- Trane Part No....Com-878
- GM Part No....2483886
- Rated Capacity at 2000 RPM
  - Maximum Head Pressure....250 psi (gauge)
  - Suction Pressure....10-45 psi (gauge)
- Initial Oil Charge....4⅔ pts.

DEHYDRATOR—STRAINER
- Make....Alco Valve Co.
- Type....Disposable
- GM Part No....2485677

EXPANSION VALVE
- Make....Alco Valve Co.
- Adjustment....External
- Setting....8°-12° Superheat
- GM Part No....2497682

HI-LO PRESSURE CUT-OUT SWITCH
- Make....Penn. Electric Switch Co.
- Type....1277MP12
- GM Part No....2468828
- High Pressure Switch
  - Opens at....375 psi (gauge)
  - Closes at....310 psi (gauge)
- Low Pressure Switch
  - Opens at....10 psi (gauge)
  - Closes at....30 psi (gauge)

CONDENSER FAN DRIVE
- System Hydraulic Fluid Capacity (Approx.)....6 qts.
- Fan Motor Speed (At 1650 Engine RPM —With Hot Oil)....1600 to 1700 rpm
- Fluid Pump Assembly
  - GM Part No....2483928
  - Make....Sundstrand Corp.
  - Model No....33-1226
- Fan Motor Assembly
  - GM Part No....2485238
  - Make....Sundstrand Corp.
  - Model No....34-6115
  - H.P. Rating....Approx. 3
- Fluid Reservoir Assembly
  - GM Part No....2489349

CLUTCH CONTROL AIR CYLINDER
- GM Part No....2415905
- Make....Midland-Ross
- Stamped....N-3869
- Stroke....1.120″

COMPRESSOR DRIVE CLUTCH
- Clutch Size....9⅛″
- Type....Single Plate, Dry Disc
- Release Bearing Type....Sealed-Ball

CLUTCH CONTROL MAGNET VALVE
- Make....Skinner Chuck Co.
- Stamped....2419272
- Model No....V5-22355

AIR CONDITIONING ENGINE OIL PRESSURE SWITCH
- Make....AC
- Stamped....1509175
- Contact Break Pressure....15±2 psi

AIR CONDITIONING CLUTCH CONTROL AIR PRESSURE SWITCH
- Make....AC
- Stamped....1508844
- Contact Closing Pressure....65 psi

MODEL "G" REFRIGERANT COMPRESSOR RECOMMENDED WEAR LIMITS AND TOLERANCES

PART NAME	ORIGINAL SPECIFICATION	RECOMMENDED LIMIT	RECOMMENDED MAXIMUM OIL CLEARANCE
Main Bearings	1.7500 - 1.7505	1.7525	.0055
Crankshaft - Main	1.7485 - 1.7480	1.7465	
Conrod - Crankpin	1.5000 - 1.5005	1.5030	.007
Crankshaft - Crankpin	1.4985 - 1.4980	1.4955	
Piston Pin	.7497 - .7495	.7490	.0011
Conrod - Pin Bore	.7500 - .7505	.7510	
Cylinder Liner	2.1250 - 2.1255	2.1270	.0065
Piston (Perpendicular to Centerline of Pin Bore)	2.1210 - 2.1205	2.1190	
Piston Rings (Gap in 2.1250 Ga.)	.003 - .008	(.030 Compression Rings)	
Valves (All)	Valves are .034"-.036" thick - should be replaced when seat grooves wear depth exceeds .010" (.016" thinnest section).		
Valve Springs (All)	Whenever compressor is disassembled for servicing, valve springs should be replaced when they have operated in excess of 3000 hours.		
Shaft Seal	Replace when leaking or when compressor is overhauled.		

NOTE 1 - The above recommended wear rates are for individual parts. For mating parts the maximum recommended oil clearance should predominate. In most cases, this means that each mating part should not be at the recommended limit.

NOTE 2 - The above recommended limits are listed as good practice for normal service rebuilding of compressors which will be reliable when returned to service. It is not necessary to rebuild a compressor when these limits are anticipated.

SPRING DIMENSIONS

ITEM	ORIGINAL SPECIFICATION
SAFETY HEAD SPRINGS	1.613 - 1.573
SUCTION SENSING SPRING	1.095 - 1.080

MODEL "G" COMPRESSOR BOLT TORQUES

ITEM	TORQUE - FT.-LBS.
Cylinder Head Bolts - 3/8" - 16 x 1-3/4"	20
Discharge Valve Cage Bolt Nut	28
Handhole Cover Bolts	20
Suction Service Valve Bolts - 1/2" - 13 x 2"	58
Connecting Rod Bolts	6
Seal Cover Bolts - 3/8" - 16 x 3/4"	20
Oil Pump Bolts	6
Pump - End Bearing Head Bolts - 3/8" - 16 x 1"	20
Discharge Service Valve Bolts - 5/16"-18 x 2"	20
Clutch Flywheel Bolt	60-65

Special Tools

References are made to special tools in some sections of this manual. These tools, or their equivalent, are necessary and are recommended to readily and efficiently accomplish certain service operations. These tools, however, are not supplied by GMC Coach Truck & Coach Division. Information regarding availability of these tools can be obtained from your GM Coach Service Representative or from the Factory. Following is a list of all special tools referred to throughout the manual.

SECTION 2 - REAR AXLE

J-8176	Bearing Puller
J-3940	Pinion Bearing Cap Remover
J-4856	Differential Bearing Remover Plug

SECTION 3 - BODY

J-2189	Seal and Insert Installer

SECTION 7 - ELECTRICAL

J-6663	T-3 Headlight Aimer
J-21091	Electrical Terminal Remover

SECTION 8 - ENGINE

VO-233	Spanner Wrench

SECTION 14 - AIR SUSPENSION

J-6888	Valve Core Replacer
J-8424	Overtravel Lever Piston Compressor
115-3	Vacuum Line Fitting

SECTION 16 - STEERING

MECHANICAL STEERING

J-544-01	Spring Scale
J-2927-01	Steering Wheel Puller
J-3186	Pitman Arm Puller
J-8176	Bearing Remover
J-3187-A	Side Cover Bearing Puller
J-2619	Slide Hammer (Use w/J-3187-A)
J-5529	Needle Bearing Remover and Replacer

POWER STEERING

J-5631-1	Pressure Checking Gauge

SECTION 19 - WHEELS AND TIRES

TA-602A	Torque Wrench
TQ-602AL	Torque Wrench with Indicator Light

SECTION 26 - HEATING AND AIR CONDITIONING

Refer to Page 395.

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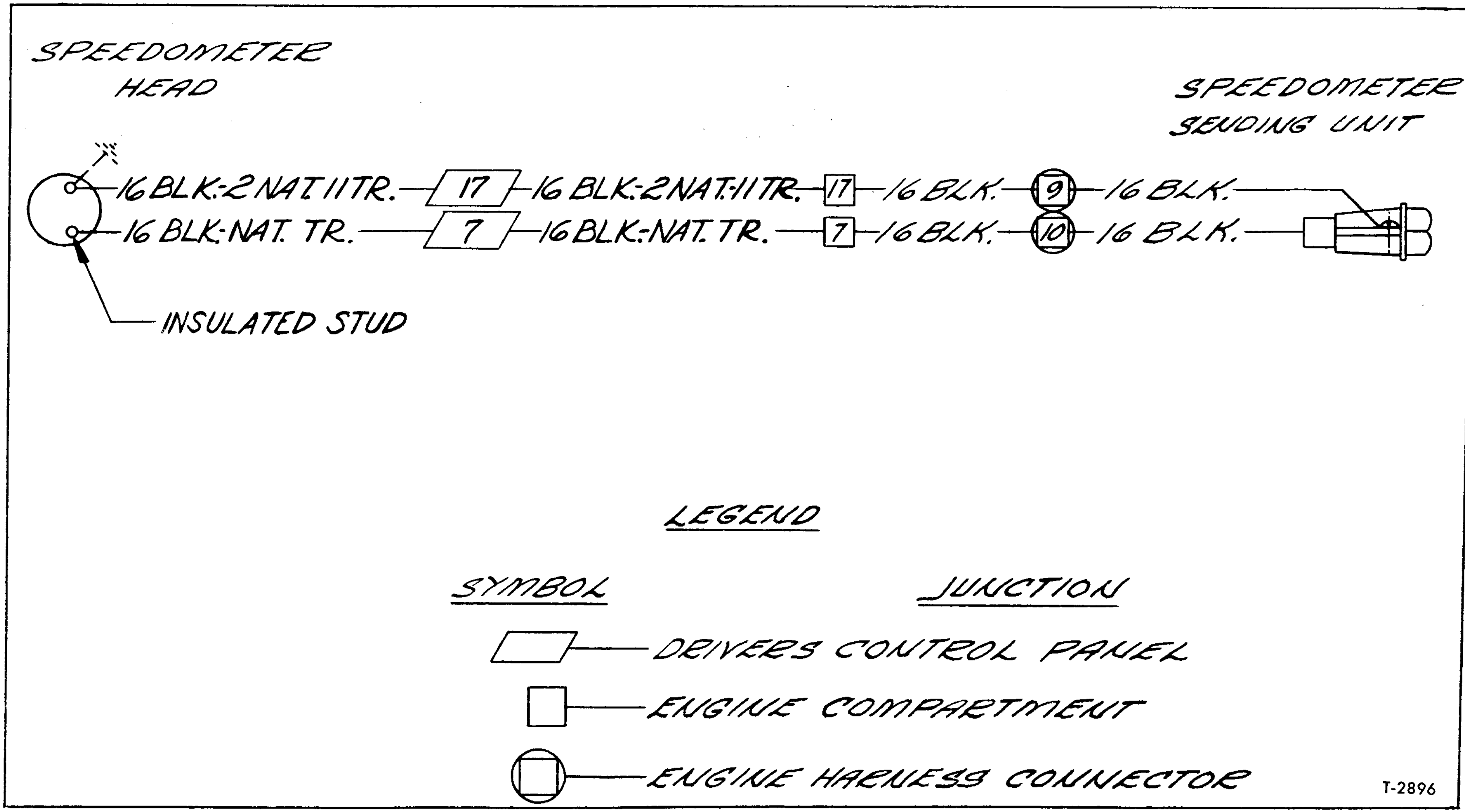
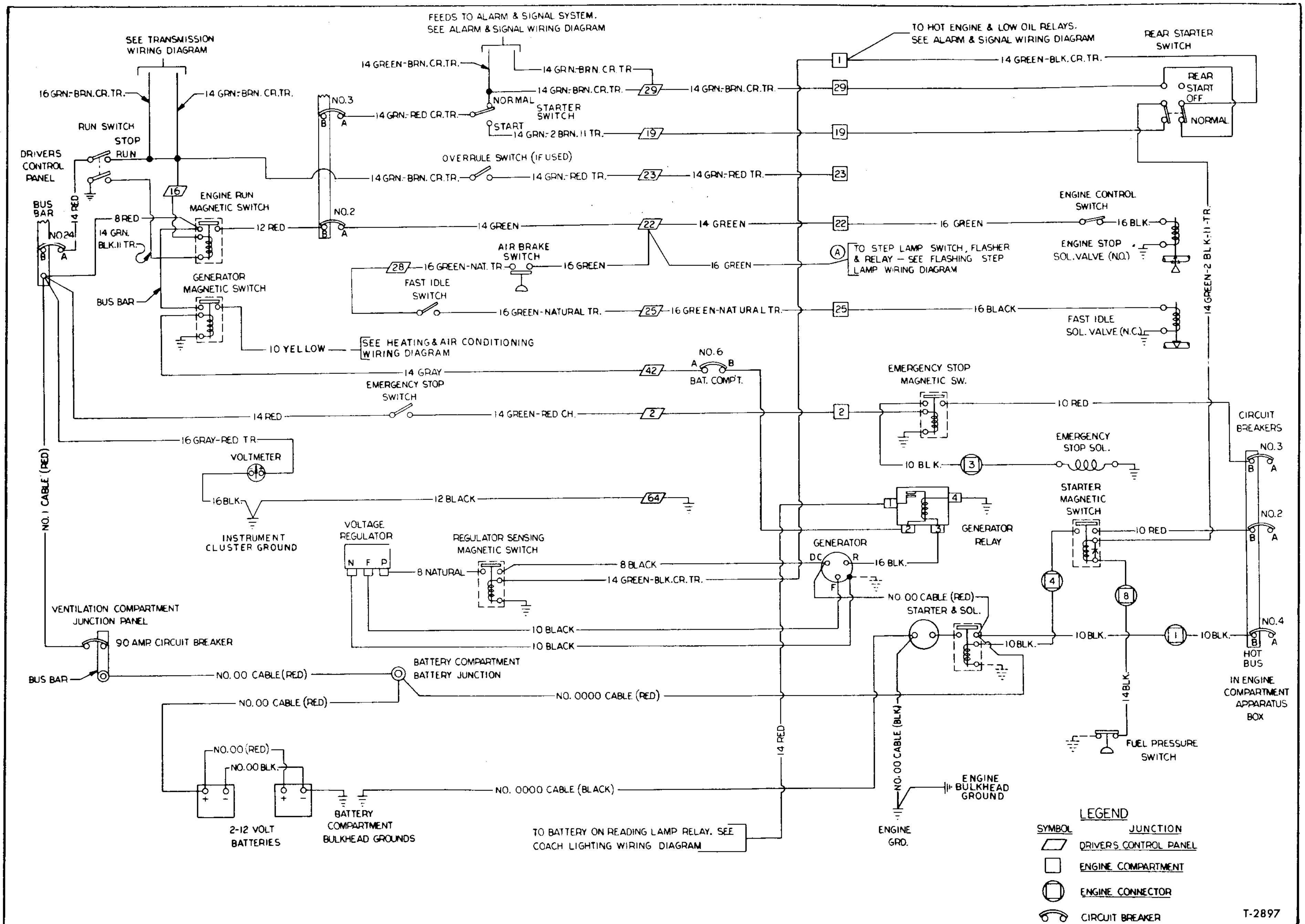


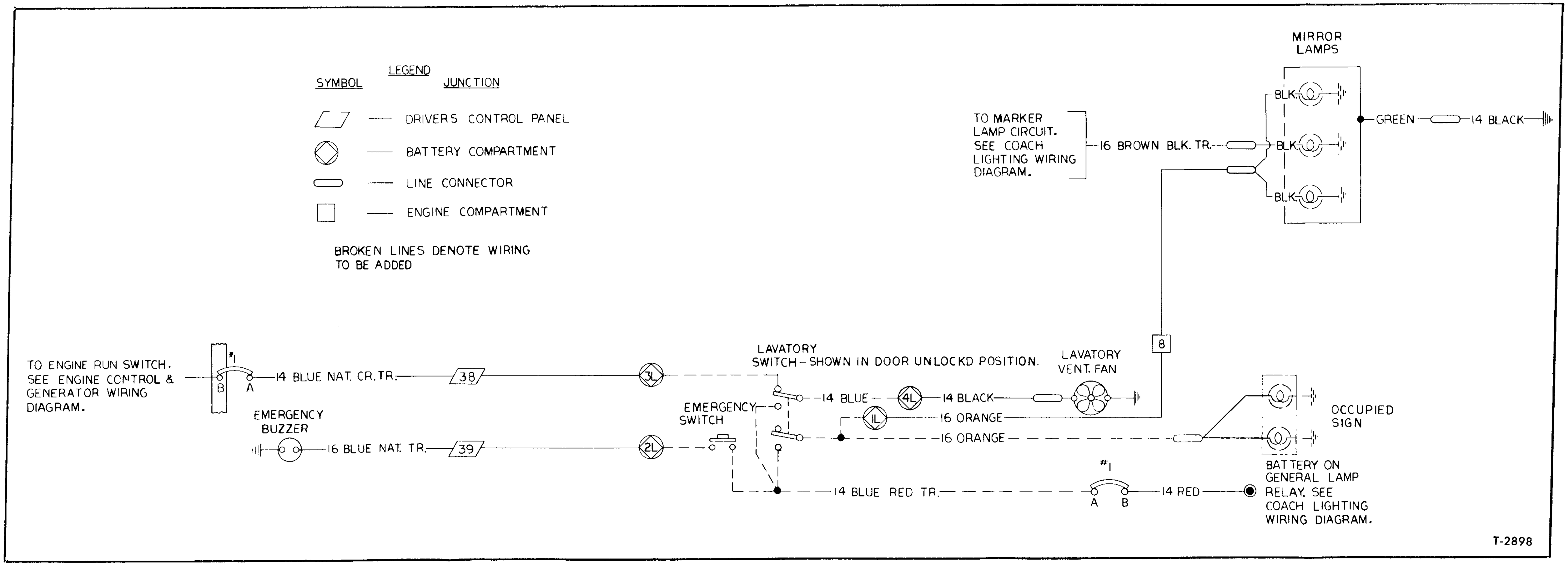
MD-97103—Speedometer Wiring Diagram

MD-97103



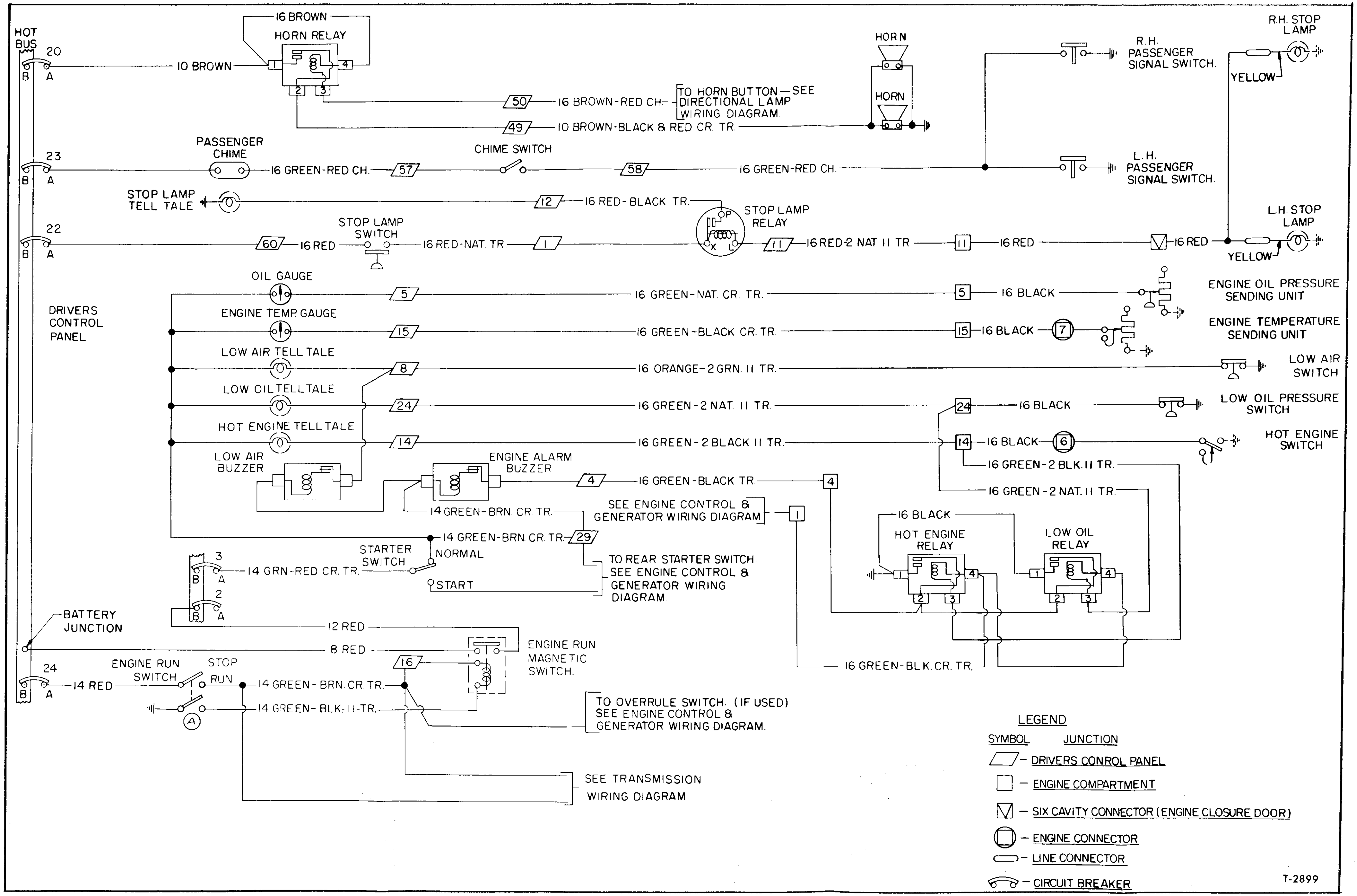
MD-97593A—Engine Control and Generator Wiring Diagram

MD-97593A

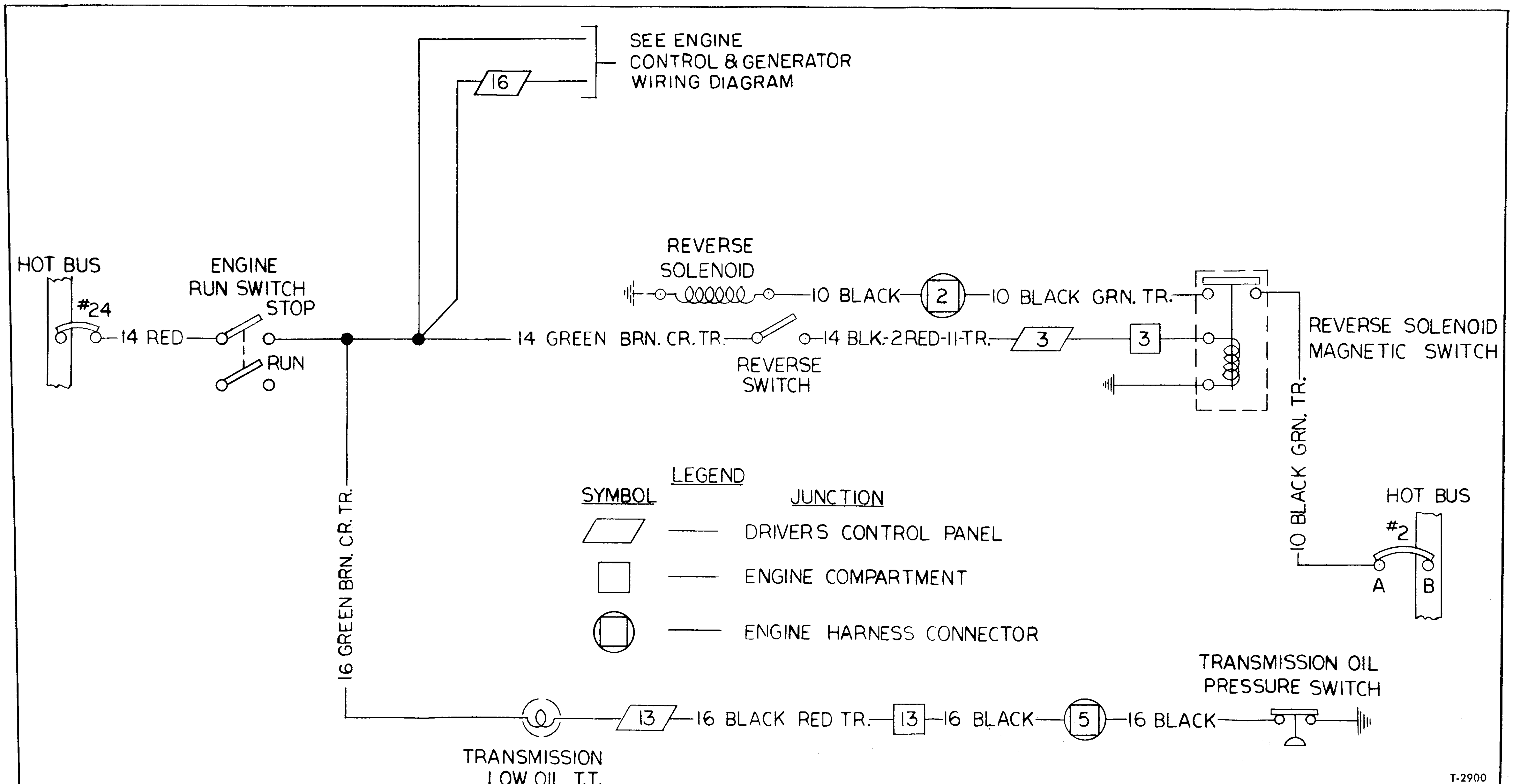


MD-97595—Lavatory Wiring Diagram

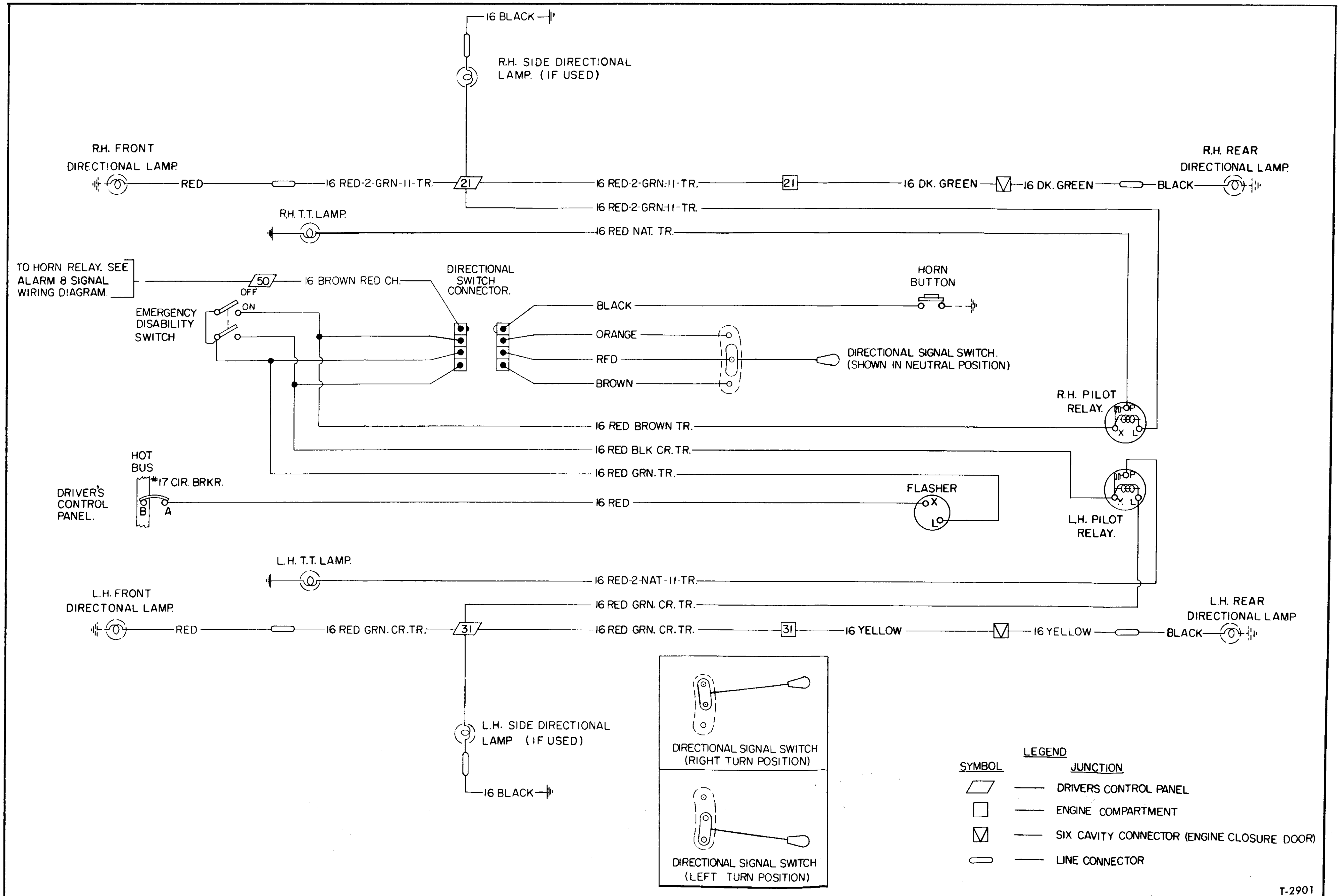
MD-97595



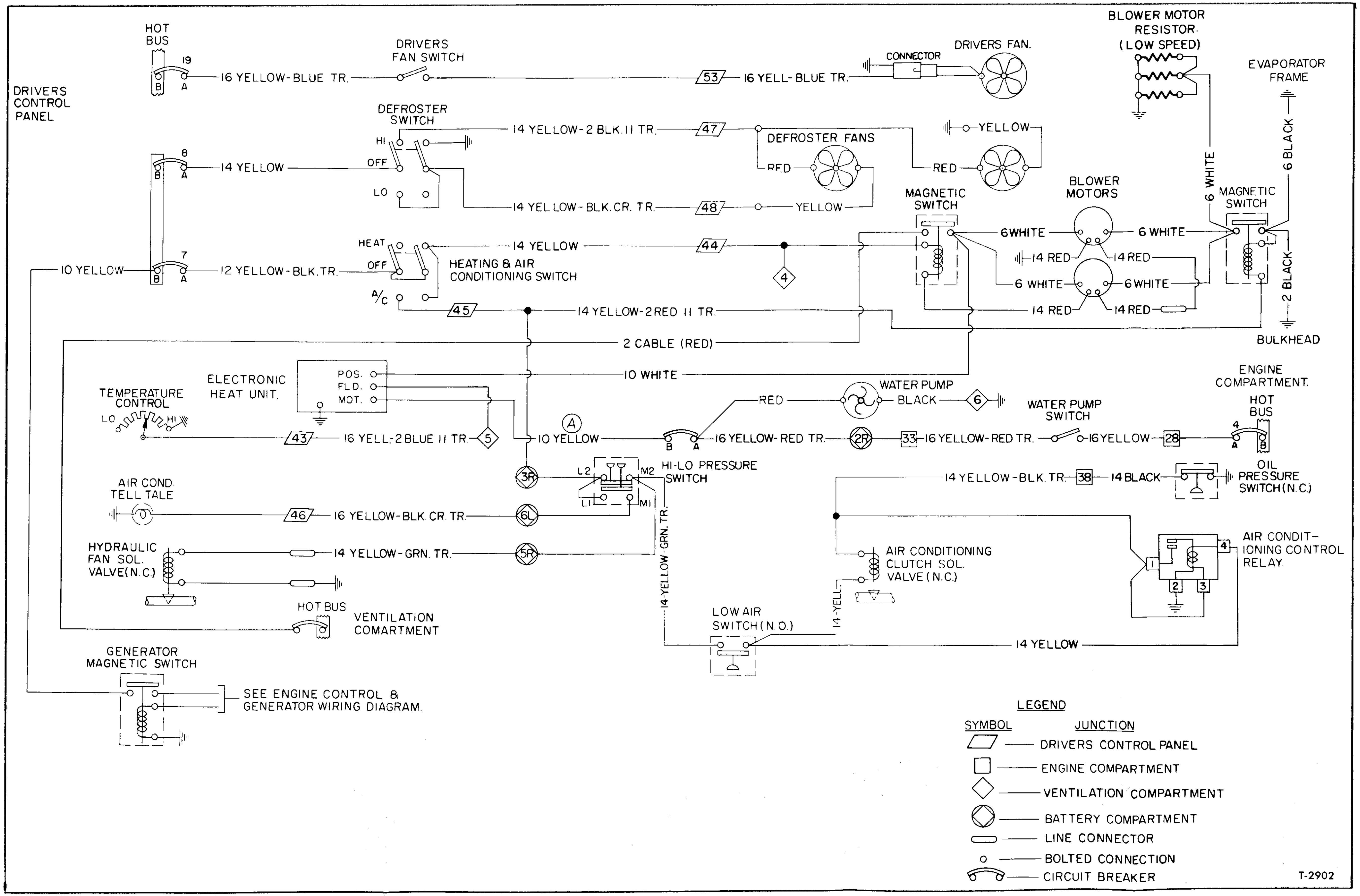
MD-97596A—Alarm and Signal Wiring Diagram



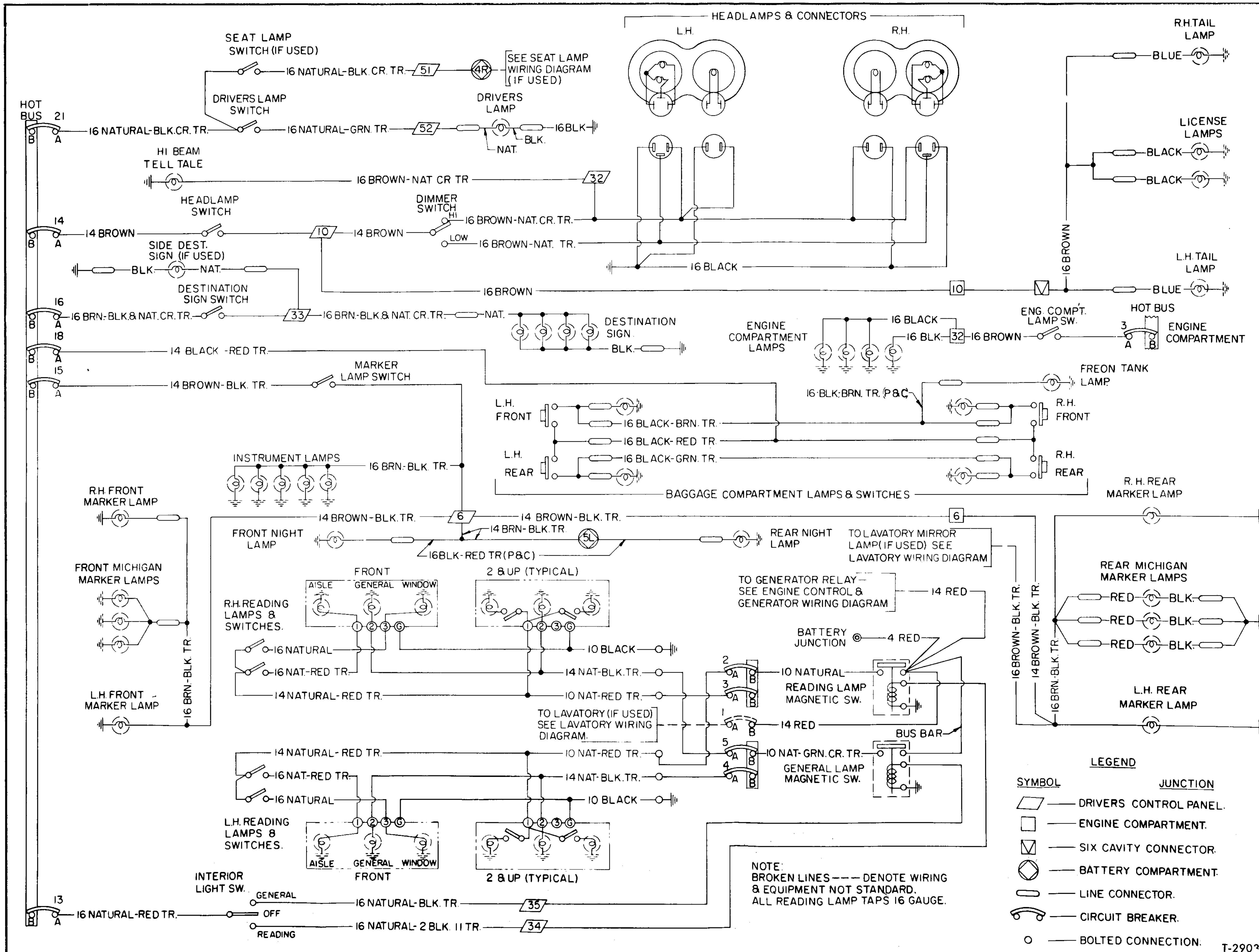
MD-97597A—Mechanical Transmission Wiring Diagram



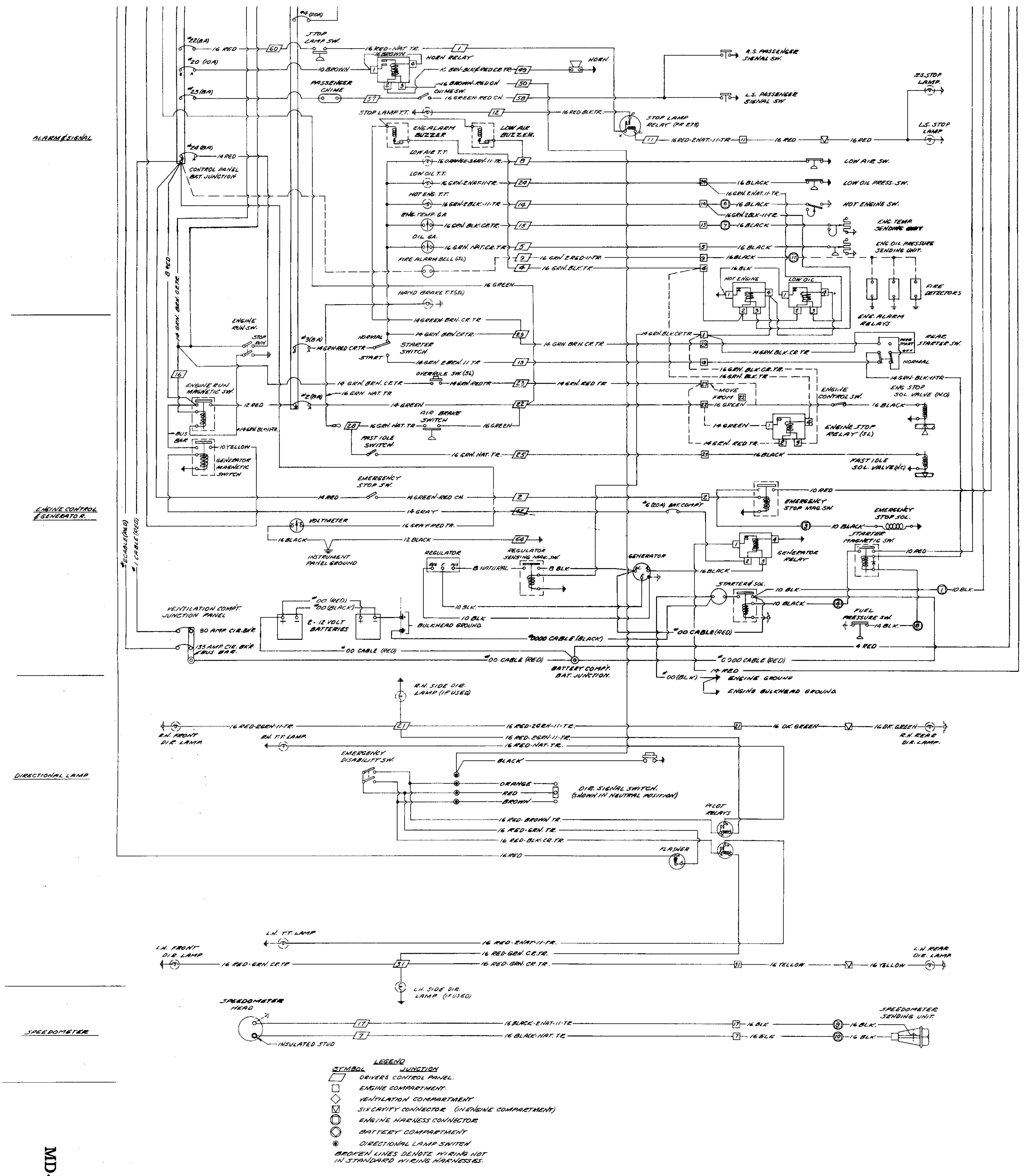
MD-97599—Directional Light Wiring Diagram



MD-98247A—Heating and Air Conditioning Wiring Diagram

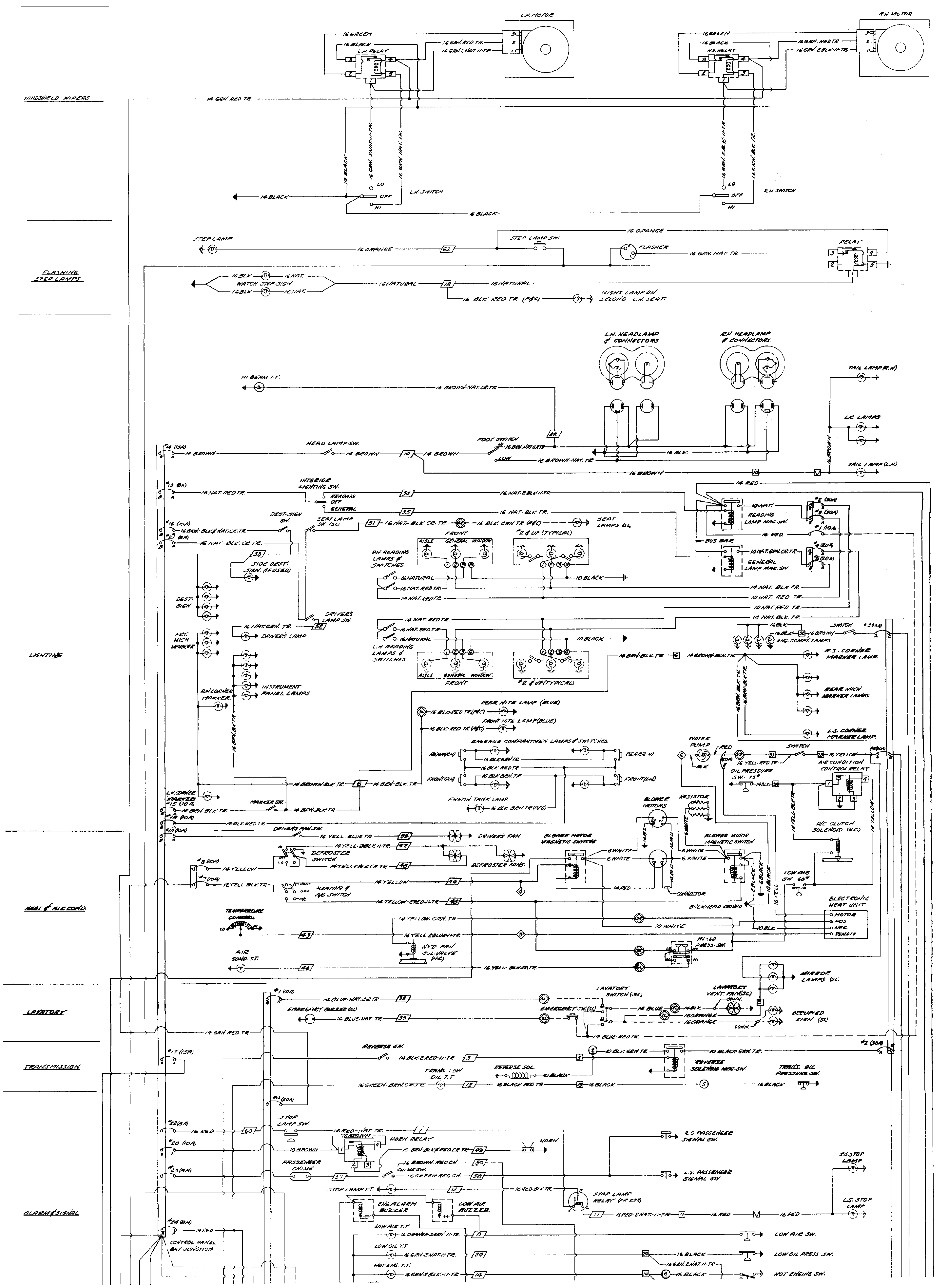


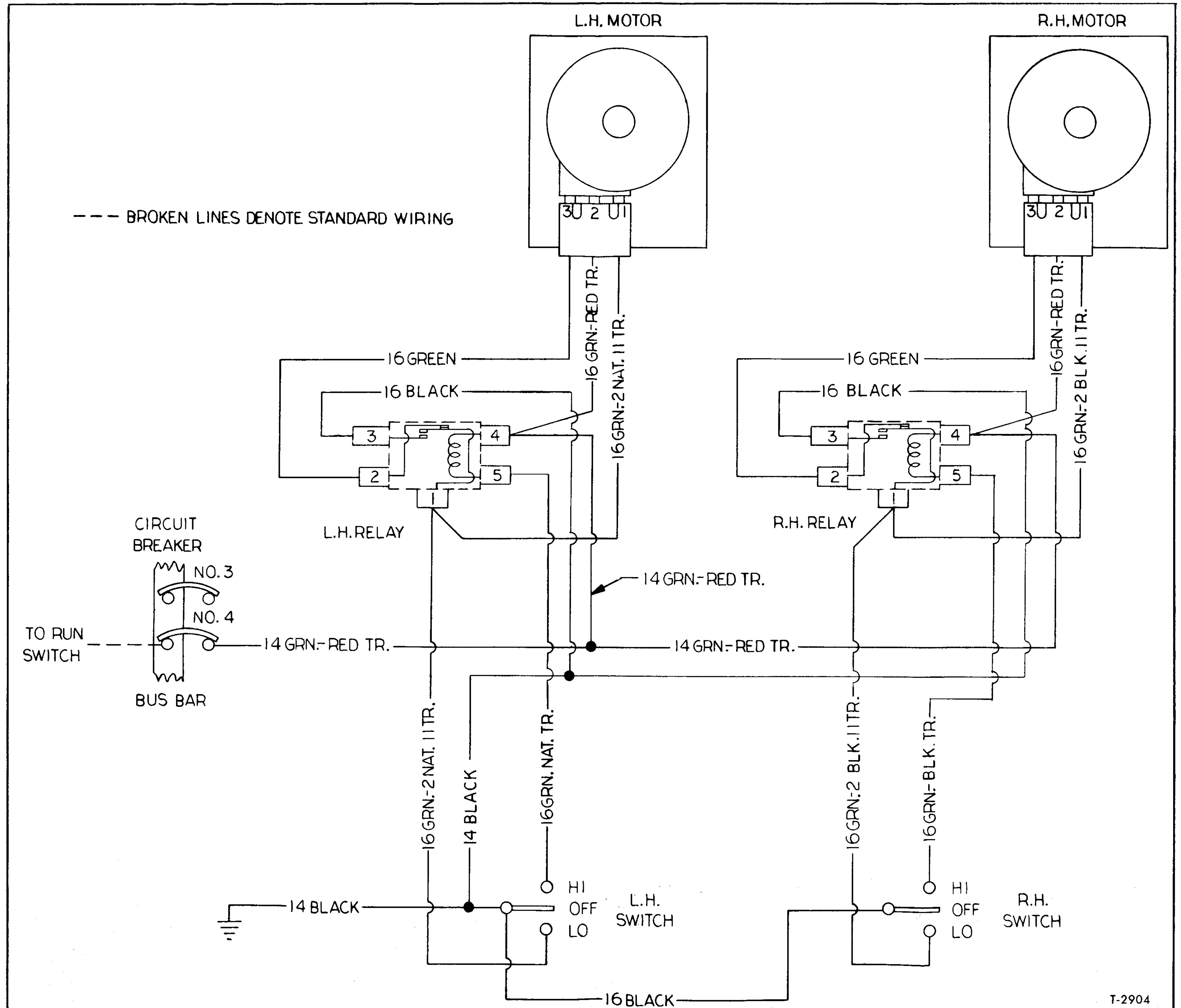
MD-98684A—Lighting System Wiring Diagram



MD-98694

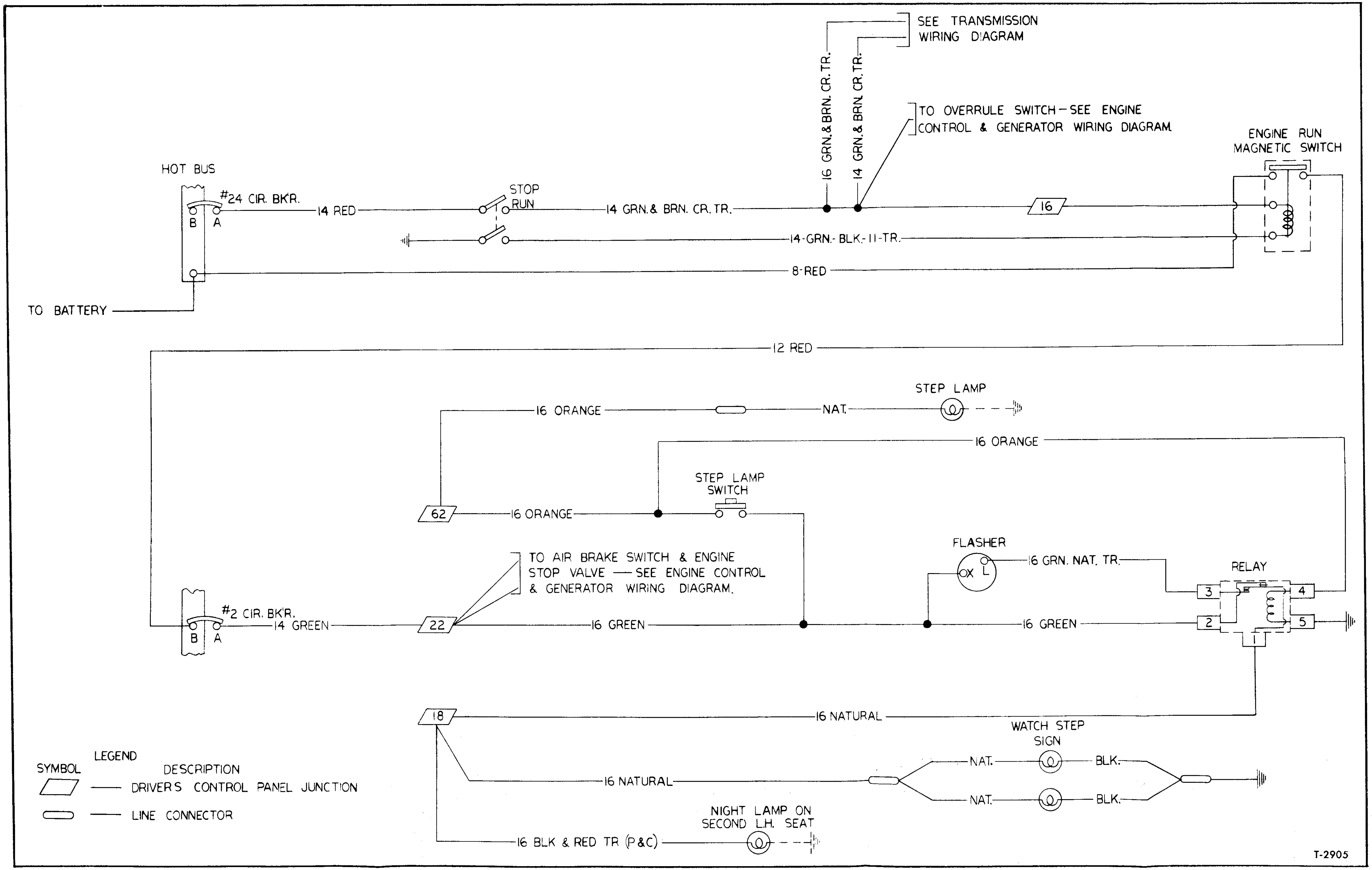
MASTER WIRING DIAGRAM
MODEL PD-4107 COACH


WINDSHIELD WIPERS
L.H. MOTOR
R.H. MOTOR
L.H. RELAY
R.H. RELAY
L.H. SWITCH
R.H. SWITCH
14 GRN. RED TR.
14 BLACK
16 BLACK
FLASHING STEP LAMPS
STEP LAMP
STEP LAMP SW.
FLASHER
RELAY
16 ORANGE
16 GRN. NAT TR.
WATCH STEP SIGN
16 NATURAL
NIGHT LAMP ON SECOND L.H. SEAT
L.H. HEADLAMP & CONNECTORS
R.H. HEADLAMP & CONNECTORS
HI BEAM T.T.
16 BROWN-NAT. CE. TR.
TAIL LAMP (R.H)
I.C. LAMPS
TAIL LAMP (L.H)
HEAD LAMP SW.
FOOT SWITCH
14 BROWN
16 BROWN
INTERIOR LIGHTING SW.
READING
OFF
GENERAL
READING LAMP MAG. SW.
GENERAL LAMP MAG. SW.
BUS BAR
DEST. SIGN SW.
SEAT LAMP SW (SL)
SEAT LAMPS (SL)
SIDE DEST. SIGN (IF USED)
DEST. SIGN
R.H. READING LAMPS & SWITCHES
L.H. READING LAMPS & SWITCHES
AISLE
GENERAL
WINDOW
FRONT
#2 & UP (TYPICAL)
10 BLACK
DRIVER'S LAMP SW.
DRIVER'S LAMP
LIGHTING
FET. MICH. MARKER
INSTRUMENT PANEL LAMPS
R.H. CORNER MARKER
ENG. COMPT. LAMPS
R.S. CORNER MARKER LAMP
REAR MICH. MARKER LAMPS
L.S. CORNER MARKER LAMP
REAR NITE LAMP (BLUE)
FRONT NITE LAMP (BLUE)
BAGGAGE COMPARTMEN LAMPS & SWITCHES.
REAR (R.H)
REAR (L.H)
FRONT (R.H)
FRONT (L.H)
FREON TANK LAMP.
L.H. CORNER MARKER
MARKER SW.
WATER PUMP
OIL PRESSURE SW. 13#
AIR CONDITION CONTROL RELAY
A/C CLUTCH SOLENOID (N.C)
RESISTOR
BLOWER MOTORS
BLOWER MOTOR MAGNETIC SWITCH
DRIVERS FAN SW.
DRIVER'S FAN.
DEFROSTER SWITCH
DEFROSTER FANS.
HEATING & A/C SWITCH
LOW AIR SW. 60#
CONNECTOR
BULKHEAD GROUND
ELECTRONIC HEAT UNIT
MOTOR
POS.
NEG.
REMOTE
TEMPERATURE CONTROL
HYD. FAN SOL. VALVE (N.C)
HI-LO PRESS. SW.
AIR COND. T.T.
HEAT & AIR COND.
MIRROR LAMPS (SL)
LAVATORY
LAVATORY SWITCH (SL)
LAVATORY VENT. FAN (SL)
EMERGENCY BUZZER (SL)
EMERGENCY SW. (SL)
OCCUPIED SIGN (SL)
TRANSMISSION
REVERSE SW.
REVERSE SOL.
REVERSE SOLENOID MAG. SW.
TRANS. LOW OIL T.T.
TRANS. OIL PRESSURE SW.
STOP LAMP SW.
HORN RELAY
HORN
R.S. PASSENGER SIGNAL SW.
PASSENGER CHIME
CHIME SW.
L.S. PASSENGER SIGNAL SW.
STOP LAMP T.T.
R.S. STOP LAMP
STOP LAMP RELAY (PR 27S)
L.S. STOP LAMP
ALARM & SIGNAL
ENG. ALARM BUZZER
LOW AIR BUZZER
CONTROL PANEL BAT. JUNCTION
LOW AIR T.T.
LOW AIR SW.
LOW OIL T.T.
LOW OIL PRESS. SW.
HOT ENG. T.T.
HOT ENGINE SW.



MD-99314—Windshield Wiper Wiring Diagram

MD-99314



MD-99959—Flashing Step Lamp Wiring Diagram

MD-99959

Lubrication Chart
(MODEL PD4107)

Item No.	Item	Remarks	Miles	Symbol
1	Engine	Keep to "FULL" mark Less By-Pass Filter - 22 Qts. With By-Pass Filter - 30 Qts.	Daily	E
2	Oil Filter	Replace element at engine drain	4,000	E
3	Blower Air Cleaner	Keep to "Level" mark - 6 Qts.	3,000	E
4	Power Steering System	Keep to "FULL" mark	3,000	S19
5	Control Rod Linkage	Brush or Spray	3,000	E
6	Steering Column Bevel Gear Housing	To level of breather	15,000	SG
7	Steering Gear Housing (At Axle)	To level of breather	15,000	SG
8	Battery Terminals	Keep coated	3,000	S3
9	Steering Knuckles	Two fittings each side	3,000	C#
10	Steering Tie Rod Ends	One fitting each end	3,000	C#
11	Steering Drag Link Ends (Manual Stg.)	One fitting each end	3,000	C#
12	Steering Drag Link Ends (Power Stg.)	One fitting - hand gun - sparingly	3,000	SG
13	Steering Booster Ends (Power Stg.)	One fitting each end	3,000	C#
14	Steering Prop. Shaft U-Joints	One fitting each joint	3,000	GO
15	Steering Prop. Shaft Slip Joint	One fitting each joint	3,000	C#
16	Prop. Shaft U-Joints	One fitting each joint	3,000	GO
17	Prop. Shaft Slip Joint	One fitting	3,000	C
18	Steering Prop. Shaft Support Bearing	One fitting	3,000	C#
19	Slack Adjusters - F. & R.	One fitting each	3,000	C
20	Brake Camshafts - Front	One fitting each	3,000	C
21	Brake Camshaft - Rear	One fitting each	3,000	C
22	Clutch Pedal	One fitting	3,000	C
23	Accelerator Pedal	1 fitting	3,000	C
24	Clutch Control Cross Shaft	One fitting each end	3,000	C
25	Transmission Control Tower	One fitting	3,000	C
26	Transmission Control Levers	Two fittings	3,000	C
27	Air Cond. Compressor Drive U-Joints	Two fittings	3,000	S29
28	Air Cond. Compressor Clutch Shaft	One fitting - very sparingly	3,000	S29
29	Destination Sign Gears	Apply	3,000	C
30	Front Door Hinges	One fitting each hinge	3,000	C
31	Windshield Wiper Shafts	2 fittings (sparingly)	6,000	C
32	Starter	See instructions	--	E
33	Air Cond. Clutch Air Cylinder	Thru plug opening - 1 oz.	10,000	E
34	Transmission	To mark on dipstick Drain and refill - 10-1/2 Qts.	3,000 15,000	E E
35	Transmission Oil Filter	Replace assembly	4,000	-
36	Rear Axle Differential	To level of filler plug Drain and refill - 22 Pts.	3,000 15,000	MP MP
37	Wheel Bearing - F. & R.	Hand pack or use lubricator Do not use pressure gun	15,000	S2
38	Brake Shoe Anchor Pins	8 fittings - 2 each wheel	15,000	S2
39	Air Conditioning Compressor	See instructions	--	S25
40	Air Cond. Condenser Fan Drive	Keep to "FULL" mark	3,000	S19
41	Speedometer Adapter	One fitting	3,000	C
42	Tachometer Cable (When Used)	Coat inside cable	25,000	SG

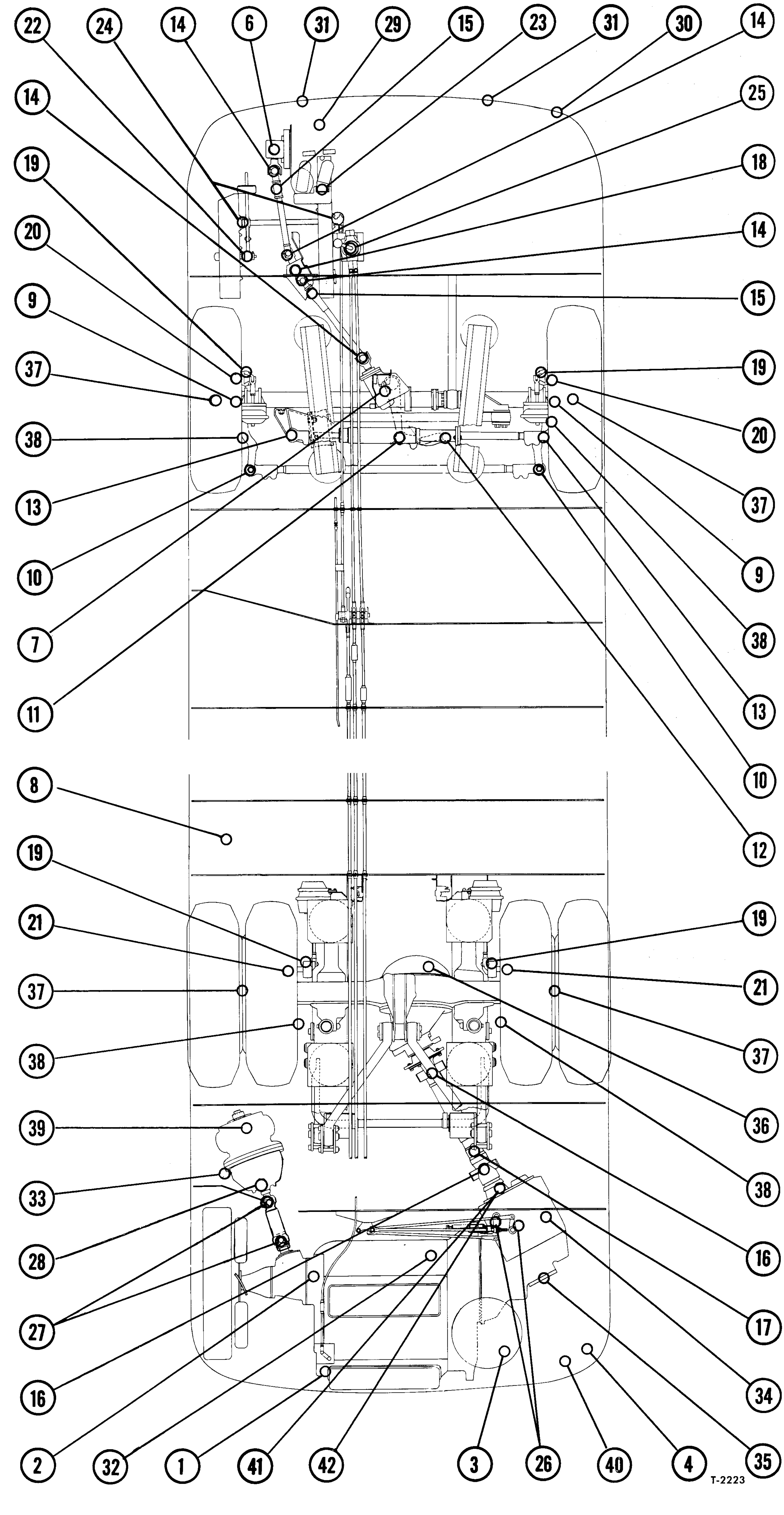
Use "SG" steering gear lubricant during cold weather.

X-6614

LUBRICANT SYMBOLS

E - Engine Oil
C - Chassis Lubricant
GO - Gear Oil - Straight Mineral
MP - Multi-Purpose Gear Lubricant
SG - Steering Gear Lubricant

S2 - High Temperature Grease
S3 - Petrolatum - Petroleum Jelly
S19 - Type A Fluid
S25 - Air Conditioning Compressor Oil
S26 - Special Multi-Purpose Grease



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